The Drills of the Arlberg Tunnel.

Written for ENGINEERING NEWS.]

BY GEO. J. SPECHT, C. E., SAN FRANCISCO, CAL.

On the 14th of November, 1883, the two advance headers of the third longest Alpine tunnel, the Arlberg tunnel, met, thus completing the first and most important link in this highly interesting enterprise. This tunnel has some features which make it more worth the careful study of the practising engineer than any other similar work.*

The location has been carefully studied and a great many variations of the line made before this one was selected as the best. The tunnel is remarkable on account of its being finished more than one year ahead of the contract time. It was worked in the most systematic manner the average progress of the advance header, as well as of every other section of the work, was more rapid than in any other similar tunnel. It is surely one of the most glorious monuments of engineering, giving great credit to all parties concerned, and showing what engineers can accomplish when they have full, free action, are left to themselves and are not hampered by political influences (Hoosac tunnel) or by a pretendingly all-knowing Board of Directors. The study of this work will prove beneficial to all engineers.

This tunnel is situated in the Empire of Austria, Province of Tyrol and will serve, in connection with the Arlberg Railway-line, to accommodate the traffic between Austria and Switzerland. The highest point is 4,310 ft. above the Adriatic sea; its total length is 33,720 ft. or 6.38 miles. The grade is 10.56 ft. per mile from the East entrance, or for a length of 13,795 ft., and the downgrade from there to the West entrance is 79.1 ft. per mile. The East entrance, 4,270 ft. above the sea, is located near the village of St. Anton, while the Western one, 3,990 ft. above the sea, is near the town of Langen. The mountain traversed is of such height that no shaft was possible, the tunnel, therefore, was driven only from both sides. The tunnel was worked by means of a bottom header, up-raises, top-headers and enlargements in sections, the length of which varied from 20 ft. to 26 ft., according to the nature of the ground. The bottom header, 9 ft. wide and 8.2 ft. high in the clear, was situated at the lowest point of the whole tunnel-section, so that the only excavation below the level of this drift was for the sub-drain and, in heavy ground for the inverted arch.

The face of the bottom header had to be in advance of any other work; this made it possible to increase the number of working faces for the top header almost at will. This is the reason that the utmost attention was given to the rapid progress of the bottom header. Every 100 ft. an up-raise was made from the bottom header until they had reached the roof of the top header: then the latter was started in both directions. There were always 3 to 4 up-raises worked simultaneously. The top-header was situated in the highest point of the tunnel-section; it was 6.56 ft. wide by 8.2 ft. high. Its face follows the face of the bottom-header at a distance of 320 ft. This top-header was worked entirely by hand as the large number of working faces made it possible to keep up with the bottom-header, which was driven by machine-labor. The further proceeding, the enlargements and the arching was done according to the so-called English method. (See Drinker pp 301-351.)

Hand Labor.—The work at the East portal was commenced on June 24, 1880, and that on the West portal on June 25, 1880. From that time to November 17 and November 23, respectively, hand labor only was used, making the following progress:

EAST HEADER.

Total length of bottom header driven in that time	677 ft.
Average progress per 24 hours	4.7 ft.
Total length of top header in same time	623 ft.
Average progress per 24 hours	4.25 ft.

WEST HEADER.

Total length of bottom header driven in that time	745 ft.
Average progress per 24 hours	5.28 ft.
Total length of top header in same time	551 ft.
Average progress per 24 hours	3.94 ft.

The larger progress in the West header had its reason in an additional face made by a side drift. The cross-section of the bottom drift was 8.2 ft. high by 9 ft. wide: 3 gangs, each of two miners working in the face at one time; while the top drift was 7.5 ft. high and 6.6 ft. wide: 2 gangs, each of two miners working. The experience of the Leggisstein tunnel of the Gothard R. R. was, that better progress can be made with a header of 95 square feet face and 6 men working simultaneously, than with one of 61.5 square ft. and with 4 men.

In all long tunnels the question "in how short a time can it be completed?" is the most important one. In laying out the programme for the construction of the Alberg R. R, the Austrian government engineers—the road is being built by the Imperial government (department of State railways)—had the experience gained in the Mont Cenis and St. Gothard tunnels, to fix upon the time when this tunnel would be finished. A probable progress of of 10.8 ft. per 24 hours in each heading was accepted as the base of the programme. It was decided to use two different systems of drills, on the East side where the supply of water is plenty, the percussion drills of the St. Gothard, system Ferroux and Séguin & Welker, and on the West side where the supply of water is limited, the hydraulic rotary drills, system Brandt, which requires much less power than the former. The latter system—used in a number of tunnels and mines in Germany and Austria—had given such promising results that it was thought best to give it a thorough trial and to practically test the superiority claimed for either. It was believed that a few months would decide this question, but unfortunately, the ground on the West side was so different from that in the East header, that machine drilling had often to be dispensed with and much time was lost by timbering, while on the East side the ground was very favorable, dry and rarely requiring any timbering.

The rock passed through consists of crystallized and micaceous shales containing a variable proportion of quartz. The quartz is most abundant in the East and the rock there approaches the gneiss. Mica predominates in the West where the rock is broken up and less compact, giving rise to infiltration of water, necessitating the use of timbering.

The rock drills of the present time may be divided into the following three groups, according to the manner of working the drill-bit:

1. Percussion drills with alternating motion.
2. Rotary drill with diamond bits.
3. Rotary drills with steel bits.

The percussion drill with the fore and backward motion works by the weight of the drill being thrown against the rock, exercising thereby such a pressure upon the stone, that its crushing strength is overcome and the rock is pulverized. The drill-bit is made to turn around its own axis and an approximately round hole is made by frequent and quickly repeated blows. The principle of the percussion drill is therefore the great pressure produced by repeated blows.

The rotary diamond drill rotates the bit rapidly and presses it with a low pressure against the rock. The drill-hole is solely made by the grinding and shaving action of the bit. The principle of this drill is based upon the greater hardness of the tool. Diamond drills can never be used under high pressure, as the crushing strength of the diamond is small in comparison to that of other materials. The crushing strength of the rock does not play any part in the work of the diamond drill. This is the reason why they do better work in homogeneous solid rock of uniform structure, than in stratified rock of unequal hardness and consistency, and that they do not work at all in soft ground.

The rotary steel drills—outside of the Brandt drill—are partly imitations of the diamond drills, and operate by spiral steel bits, which are rotated by some mechanical device, being simultaneously pressed against the rock, and producing the hole by the combination of the shaving and pressing action of the boring tool. This kind of drill can be used only in soft material. In hard ground the pressure is not sufficient, and the shaving motion wears off the steel points very rapidly.

The principle of the Brandt hydraulic rock drill is different from any of the percussion or rotary drills. The direct pressure of a percussion drill is not sufficient to overcome the crushing strength of the rock, the *vis viva* of falling masses, the drill bit has to assist the pressure to do the desired work. The mechanical labor is very uneconomically expended in a percussion drill. The idea suggests itself, whether this same amount of labor cannot be applied in a better manner

Mr. Brandt uses in his drill a constant high hydraulic pressure, which presses the tool (drill-bit) with such a force against the rock that the latter is crushed, under all circumstances. As the crushing strength of hardened steel is greater than that of any known rock, the points of the drill-bit—provided the necessary pressure is applied—must also penetrate into the rock. In order that these points always exercise their pressure on fresh ground, they have to be rotated, by which rotation the rock is crushed and broken, but not pulverized and shaved. These two points—high, quiet pressure on hardened steel, and slow rotary motion, to overcome the crushing strength of the rock—form the principles of the Brandt hydraulic drill. The pressure being constant, and being exercised in one direction only, the mechanical labor required is less, and the percentage of work accomplished is greater than in any percussion or rotary drill. It has been proved that the actual useful effect is from three to four times greater in the Brandt drill than in the percussion drills. This makes it possible to use the Brandt drill where too little power is at disposal to employ percussion drills.

The drilling machine proper consists of a cylinder and a piston (Fig. 21); the cylinder carrying the drill-rod. By introducing water, under pressure, into the cylinder, the same, and with it the drill-bit is pressed against the rock. The rotary motion of the drill is imparted by two small hydraulic engines, coupled together under 90°, with differential pistons, and fastened to either side of the cylinder. The valve-motion of these engines is so arranged that the right hand one steers the left hand one, and *vice versa*. These engines turn a worm, and by it a worm wheel, which is connected with the rear end of the cylindrical shell surrounding the pressure cylinder. This shell carries at its farther end the drill-rod, rotates with the worm, and therefore causes the drill-bit to rotate also. The continuous advance of the drill is effected by the direct hydraulic pressure on the cylinder. The cleaning of the drill hole is done by the water, escaping from the hydraulic engine, and led through the hollow drill-rod to the bottom of the hole.

As further illustrating the principles of the Brandt drill the following description is given, reference being had to the accompanying plan:

Fig. 21 is a longitudinal section of the cylinder with the piston and a cross-section of column. The back part of the cylinder is *uninterruptedly* connected with the pressure-water through the port *a*. Now, if pressure-water is admitted through *b* into the other part of the cylinder and the exit at *c* is closed, the cylinder and with it the drill-rod and bit is pressed forward by a pressure corresponding to difference of the areas of the piston. With *b* shut and *c* open, the cylinder moves backward with a pressure corresponding to the annular area of the piston. With *b* and *c* both closed, the cylinder remains stationary. Fig. 22, explains the principle of the small hydraulic engines, turning the drill. The working piston is a differential piston. The forepart of the cylinder is continuously connected with the pressure-water through *e*. The distribution of the pressure-water takes place only in the back part of cylinder by means of a piston-valve. The water used runs off through *a*. Fig. 23 shows the accumulator. The pressure-water is admitted uninterruptedly into the cylinder through the port *a*. If the pumps deliver more water than used, the piston of the accumulator rises above the upper section of the cylinder; allowing the water to escape through *h*. The weight is regulated by the addition of iron plates.

The drill rod consists of a number of longer and shorter sections of a tube, with flat screws at either end. They are quickly joined and disjoined by means of a wrench—much quicker than the change of drills in the percussion—drills.

The shell above mentioned, allows the machine to advance a length of 1.1 ft.; the rod, therefore, must be extended every 0.82 ft.—0.98 ft. of drill-hole. The drill-bit has three, four, or five points, according to the hardness of the rock, which protrude a little beyond its edge, making the largest diameter of the bit 2⅛ in. while the cylindrical part of the bit has a diameter of 2¼ in. (Fig.). This prevents, effectually, any striking of the drill-rod. The drill-rod and bit being hollow, a core is obtained, giving an exact record of the ground traversed, The mechanical labor of the machine, therefore, is confined to the area represented by this ring, which again is a great saving in power over the percussion drill, where the entire area of the hole must be worked away.

Contrary to the deafening noise of the percussion drills, this drill works perfectly noiseless, only the crushing of the rock under the enormous pressure of the drill being audible.

The whole machine is supported by a column (Fig. 24). This is constructed after the principle of the hydraulic press, with differential plunger-piston. The pressure acts constantly upon the annular space; the opening or closing of the ports *c* and *b*, cause the advance or backward motion of the piston; if both are closed the piston remains stationary. The piston has a diameter of 7⅛ in. Deducting the counter-pressure on the annular space, the pressure on the piston is theoretically 51,400 lbs., the water from the accumulator having a pressure of 1220 lbs. per square inch. The piston can move a length of 1 ft., 8 in., it is open at one end, so that the whole column is filled with water, thereby increasing its stability. The weight of each column is 660 lbs., filled with water. The machine can be moved up and down on the column and can be swung around the same horizontally. It is kept in position by a clamp. The hind part of the machine, which remains unmoved and stable during the work, is connected with the clamps by a hinge. By means of a nut the machine can be turned on this hinge and so assume any desired position.

The time required in setting up column and machines ready for drilling is—in good, solid ground—from eight to ten minutes. Four drills are supported by one column. Water being admitted into the column, the plunger is forced against the rock thereby forming a solid abutment. The drills remain attached to the column, unless requiring thorough repairs. The column rests horizontally on a carriage, and is handled by means of a long lever and a counter-weight. After it is brought in proper position, water is turned on and the column is pressed against the sides of the drift. The motors furnishing the necessary power are four Girard turbines (3 used, 1 in reserve) with horizontal axis, and an exterior diameter of 10′ 6″; interior diameter of 9′ 4″. The buckets, 120 in number, are made of steel from 4⅛″ to 13″ wide; they make 160 revolutions per minute, which corresponds to a velocity on the circumference of 69 ft. per second. The turbines drive three groups of four pumps each by means of geared wheels (3:8) and crank-shafts. The piston is a differential plunger with diameters of 1⅞ in. and 2½ in.; the stroke is 2 ft. 2 in.; the speed sixty revolutions per minute, and the quantity of water delivered 0.44 gals. per second. The valves have large passages and therefore a very small lift, only ⅛ in. The suction-pipe has a diameter a little larger than the large diameter of the plunger, and the pressure pipe one a little larger than the small diameter of the same. The pumps draw only one way, but press in either direction. They take the water from a canal, situated between the foundations, which is fed

*The data for this article are taken from the official publications of the Imperial department of railroads, and the semi-official publications in the papers of the Austrian Society of Architects and Engineers, also from from private letters and reports.

Railroads.

BOSTON, Jan. 7.—The Nantasket Beach Railroad was sold at auction to-day for $100,000 to satisfy the claims of its bondholders. The purchase was made, it was understood, in the interest of the bondholders.

OTTAWA papers say there is little likelihood of the construction of the projected railroad from Cornwall, Ontario, to Soul Ste. Marie, there to join the Northern Pacific R. R.

A GALVESTON dispatch of Jan. 4, says that on that day the Mexican International R. R. entered Monclova, 144 miles from Eagle Pass. It is thought that construction on this road will stop there for an indefinite time.

THE Keystone Railroad Co., and the Philadelphia Rapid Transit Co., propose to build an elevated railroad in Philadelphia, from Cobb's Creek and Market street, in West Philadelphia, across the Schuylkill to Seventh and Market, then branch north to Third and Berks, and south to Wharton street.

APPLICATION was made at the Pa. State Department on January 5, for a charter to the Pittsburg and Allegheny Central Railway Company, capital stock $1,200,000. The company proposes building a railroad from Chartiers Township, Allegheny County, to New Salem, Westmoreland County, a distance of 40 miles.

THE Trenton *Times* of January 3, says: "The Reading Railroad has notified all of its employes holding public positions to resign their offices or leave the company's employ. Among the employes affected by this order are two members of the incoming Legislature. Even those employes who hold the office of School Trustee have been forced to resign."

A DISPATCH from Altoona, Pa., says: "The twenty-year lease of the Pullman Palace Car Company to the Pennsylvania Railroad Company will expire shortly; and in view of this fact the latter company is making arrangements to construct elegant cars for its own use." This may be one cause for the weakness in Pullman stock,

THERE is every indication that the Pennsylvania Railroad will extend its Schuylkill Valley branch to Pottsville and connect at that place with the Lehigh Valley Railroad, both companies occupying the same depot, which will be erected on Coal and Norwegian streets, on the property recently purchased by the Pottsville & Mahanoy road.

AN earnest effort is again being made by Mr. Charles Stoughton to have Congress authorize the Secretary of War to contract with him for the improvement of the Harlem River. The plan proposes to construct a channel from the Hudson River to or near the end of Randall's Island for a sum not exceeding $1,295,000. The channel is to be 225 feet wide and 15 feet deep at mean low tide and to be completed on or before Dec. 31, 1885.

WORKMEN engaged on the Bozeman tunnel of the Northern Pacific railroad in Montana came together December 22, and it is expected that track will be laid and trains run through by January 10. The tunnel is 3,610 feet in length, 17 feet wide and 21 feet high in the centre. Work on the approaches was begun in the fall of 1881, and on the tunnel proper in the spring of 1882. From 80 to 100 men have been employed constantly on the work, and the total cost when completed will be about $300,000.

A DISPATCH to the Chicago *Journal* from Springfield, Ill., says the incorporation of the Lake Erie & Mississippi Railway Company was effected there on Jan. 7, with Columbus B. Cummings, George A. Ives, John B. Cohoes, and Luther M. Dearborn as incorporators, and who constitute the first Board of Directors. The company is formed to construct a road from Bloomington to Peoria, Ill., and thence westward to the Mississippi.

THE Governor of New Jersey, in his annual message, sent in on January 8, says that the investment in railroad property in that State amounts in a carefully prepared estimate to $227,384,534. The tax levied upon railroads last year was $677,557.76, which is less than one-third of one per cent. Other property in the State is taxed at rates varying from one to three per cent.

A MEETING of the stockholders of the North River Construction Company, which is building the New York, West Shore & Buffalo Railway, was held at Weehawken, January 8th. The following Directors were elected: Edward F. Winslow, Charles Freeman Smith, Michael P. Grace, Thomas W. Lillie, Walter Katte, Howard Mansfield, and George G. Nevers of New York; Conrad N. Jordon, of Englewood, N. J., and Charles Bard of Norwich, Conn. The voting was by proxy mostly. The stock in trust controlling the company was voted by the Trustees. No statement of the condition of the company was presented.

THE Pennsylvania Railroad Company has purchased the Eastern Shore Railroad at a price approximating $450,000. The Eastern Shore Road runs from Delmar, Del., to Crisfield, Md., a distance of 38 miles.

THE excavations from the east and west ends of Gould's Tunnel, near Steubenville, Ohio, have met about 2,300 feet from the east end. The tunnel is completed for about 2,000 feet in the east end and 800 feet in the west end. It is nearly four years since the work was commenced, and 300 men have been employed on it night and day. It will be 3,300 feet long, and will do away with the most dangerous curves on the Panhandle Railroad, saving about 2½ miles of travel. It is expected the tunnel will be completed in February.

THE Reading R. R. Engineers are locating lines in Pottsville, Pa., with a view of preventing if possible, the entrance of the Penn'a. R. R. into that city. It seems that approach from the south is only possible on two streets, one is entirely occupied by the Reading R. R. and the other is now being located upon. The rival engineer corps of the Pottsville & Mahony new branch, in the Penn'a R. R. interest also arrived on the ground on Jan. 3, and both parties are busily at work.

WASHINGTON, Penn., Jan. 7.—Contractors will be at work in a few days on the extension of the Hempfield, Baltimore and Ohio Railroad between Washington and Connelsville, a portion of the work having been already let. The remainder will probably be awarded this week. The first work will be at Brady's Tunnel, a short distance from here, which was begun but abandoned 10 or 12 years ago. It is considered in a dangerous condition. When finished this line will give the Baltimore and Ohio a shorter line between the East and West.

THE annual report of the Railroad Commissioners of Massachusetts was submitted to the legislature Jan. 7. During the year ending September 30, 1883, there were 3,798 additional miles of railway constructed in the State. The aggregate capital stock was $122,367,572. The net debt of the companies amounts to 72,933,290. The total gross income for the year was $43,380,387; total expenses, $32,479,907. The local passenger earnings were $13,652,320; through passengers carried was 61,530,747. The whole number of tons of freight carried was 20,202,881. The number of persons injured during the year was 524 and the number killed was 191, 15 being passengers. Upon the Sunday train question the Commissioners say that to authorize a Sunday train on an abstract argument against Sabbath observance without proof of any demand for the train would show disregard of the spirit of the law passed in 1881, and would be a breach of trust. There is no doubt that the law should be constrcted as authorizing permission for the operation of a road when it is called for by mixed considerations of convenience and necessity.

SOUTHERN RAILROAD NOTES.—Steps are being taken to build 50 miles of lines from Baltimore to the Virginia Midland at Alexandria.

It is reported that a syndicate intend to build a road from Linwood, Rockingham Co. Va. and the Shenandoah Valley R. R., to Harrisonburg, twenty miles and then westward about one hundred miles. It is in the interest of the Dora coalfields and Baltimore owners.

A charter has been secured for a road from Mound City, Ark., five miles above Memphis, to the St. Francis River, near Wiltsbury, twenty-six miles.

The Fort Smith & Hot Springs R. R. has secured a charter; it is ultimately to proceed south to connect with New Orleans lines. A survey has been made.

It is proposed to build a railroad from Danville, Va., south-east into Caswell Co, N. C., thence east to Middleburg on the Raleigh & Gaston R. R. a total distance of about twenty miles.

WORK on the approaches of several of the large tunnels recently let on the line of the new South Penn. R. R. has been commenced in good earnest by the contractors, most of whom are already on the ground, and they propose to lose no time in getting to their headings, which will be driven in from both ends of each tunnel simultaneously.

The most improved drills and other tunneling machinery will be used on this work as the time for the completion of the tunnel is limited so that very rapid progress will be necessary if they are to be finished in time.

The contractors on the Allegheny, Sidling Hill and Kittatiny tunnels have already placed their orders with the Ingersoll Rock Drill Co., of New York, for the necessary plans of machinery, so there will be no delay in having all the requisite appliances on the ground and ready for work by the time they are needed.

The driving of these tunnels will be watched with considerable interest by railroad contractors and others, because from the experience and reputation of the men who have charge of the work and the character of the machinery they propose to employ, some very "tall' driving is expected. The tunnels are double track, 27 feet wide by 22 feet 6 inches high, and their total length exclusive of approaches is 36,160 feet, or nearly seven miles.

IRON, METAL AND COAL MARKETS.

PHILADELPHIA, Jan. 10, 1884.

There was a better feeling in the Eastern Pennsylvania iron trade during the past week, owing to the fact that stocks at furnace-banks and in consumers yards, are found to be even lighter than was supposed, and also to the fact that inquiries for all kinds of Iron are coming in more freely. Foundry Iron is quiet and dull at $20.50@$21. Forge is in rather better request at $18@$18.50 for good brands. Bessemer and Spiegeleisen are under active inquiry. Bessemer is quoted at $20@$20.50. Some large lots of Spiegeleisen are under negotiation at $28.50@$29. Most of the Steel Rail mills are well supplied with business and are refusing to accept the prices which were willingly taken in December. Quotations are now held firmly at $35 for prompt and $34 for future delivery, and large transactions will probably be closed within a few days. 20,000 tons are under negotiation at $34.50 asked. Manufactured Iron is in a little better request and is quoted at $1.80@2c. at mill, though small store lots commanded in some cases $2.10. Nails are firmer at $2.45@$2.55. Structural Iron is under active inquiry and a large amount of business is likely to be placed for elevated road requirements.

CHICAGO, Jan. 9, 1884.

Dullness is the general characteristic of the iron trade of this section, but some dealers report that they have received a fair number of inquiries for this year, and some of them from large consumers who will shortly be in need of heavy stocks. Some buyers have offered to place orders for Iron to be delivered throughout the year at present quotations, but as makers have strong faith in an early improvement in demand and in price, these offers have not been accepted. The trade in Manufactured Iron is quiet. Bars are quoted in ordinary jobbing way on the basis of 2c. Structural Iron is quiet at $2.60 for Tank; $2.70 for Angle; Beam, $3.60; Channels, $3.80; C. H. No. 1 Flange, $4.50; C. H. No. 1 Shell, $3.50. The suspension in nail making has imparted strength to prices. Former quotations are continued at $2.55@$2.60. A fair number of small orders for Pig Iron have been placed, and there are inquiries for large lots. Heavy purchases will probably be made within a short time. There are indications that an improvement will take place in Lake Superior charcoal brands. Demand for Steel of the higher grades is reported fairly active, but prices for lower grades have been badly cut. Scrap Iron is dull. Quotations unchanged.

PITTSBURGH, Jan. 10, 1884.

There has been little change in the situation the past week and business is about as dull as ever, but iron men are hopeful that there will be an improvement within a week or two. Stocks are light in first and second hands and consumers, as a rule, will have to come into the market within a very short time. City furnaces are holding standard brands of Lake-ore Forge Iron at $18, four months, and refuse to sell for less, but equally good irons from outside furnaces can be had at $17 cash. Foundry Iron is in light demand at $18@$21 but a small sale of Charcoal Foundry has been reported at $25. Nails are firmer at $2.40@$2.50. No sales of Muck Bar have been reported for several weeks. All the Merchant Bar mills have resumed and are working to about three-fourths capacity. Prices are quoted at $1.70@2c. Steel rails are under better inquiry and are quoted at $35@$36 according to date of delivery. Bessemer Pig, $21@$21.50.

COAL.

PHILADELP , Jan. 10, 1884.

In consequence of the agreement to suspend Anthracite mining for three days each week, in the first three months of the year, the demand for domestic sizes has become more active. Western shipments continue, but are much lighter than formerly. Stocks of Coal are very large, and are not diminishing. It is now believed that the half-time output will be quite sufficient to fill current requirements; by this policy the companies hope to enter the spring trade in splendid condition, and hope to even be able to advance prices slightly. The Reading is quietly but surely extending its control; last week it took possession of several of its leased collieries The production of Anthracite Coal for 1883, is 31,259,985 tons as against 29,120,096 tons for 1882. Total receipts of Anthracite at Chicago for the yea, 1,136,00[illegible] tons, an increase of 38,000 tons over the previous year. Total receipts at Boston from New York and Philadelphia, 1,722,[illegible]42 tons, a decrease of 30,554 tons. Some shading of prices is going on, but as a general thing, prices are being pretty well maintained. There is no improvement in the bituminous trade, and the outlook grows, if possible, more discouraging.

The Drills of the Ariberg Tunnel.

Written for ENGINEERING NEWS.]

BY GEO. J. SPECHT, C. E., SAN FRANCISCO, CAL.

On the 14th of November, 1883, the two advance headers of the third longest Alpine tunnel, the Ariberg tunnel, met, thus completing the first and most important link in this highly interesting enterprise. This tunnel has some features which make it more worth the careful study of the practising engineer than any other similar work.*

The location has been carefully studied and a great many variations of the line made before this one was selected as the best. The tunnel is remarkable on account of its being finished more than one year ahead of the contract time. It was worked in the most systematic manner the average progress of the advance header, as well as of every other section of the work, was more rapid than in any other similar tunnel. It is surely one of the most glorious monuments of engineering, giving great credit to all parties concerned, and showing what engineers can accomplish when they have full, free action, are left to themselves and are not hampered by political influences (Hoosac tunnel) or by a pretendingly all-knowing Board of Directors. The study of this work will prove beneficial to all engineers.

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Average progress per 24 hours	3.94 ft.

The larger progress in the West header had its reason in an additional face made by a side drift. The cross-section of the bottom drift was 8.2 ft. high by 9 ft. wide; 3 gangs, each of two miners working in the face at one time; while the top drift was 7.5 ft. high and 6.6 ft. wide, 2 gangs, each of two miners working. The experience of the Leggisstein tunnel of the Gothard R. R. was, that better progress can be made with a header of 95 square feet face and 6 men working simultaneously, than with one of 65.5 square ft. and with 4 men.

In all long tunnels the question "in how short a time can it be completed?" is the most important one. In laying out the programme for the construction of the Alberg R. R. the Austrian government engineers—the road is being built by the Imperial government (department of State railways)—had the experience gained in the Mont Cenis and St. Gothard tunnels, to fix upon the time when this tunnel would be finished. A probable progress of of 10.8 ft. per 24 hours in each heading was accepted as the base of the programme. It was decided to use two different systems of drills, on the East side where the supply of water is plenty, the percussion drills of the St. Gothard, system Ferroux and Séguin & Welker, and on the West side where the supply of water is limited, the hydraulic rotary drills, system Brandt, which requires much less power than the former. The latter system—used in a number of tunnels and mines in Germany and Austria—had given such promising results that it was thought best to give it a thorough trial and to practically test the superiority claimed for either. It was believed that a few months would decide this question, but unfortunately, the ground on the West side was so different from that in the East header, that machine drilling had often to be dispensed with and much time was lost by timbering, while on the East side the ground was very favorable, dry and rarely requiring any timbering.

The rock passed through consists of crystallized and micaceous shales containing a variable proportion of quartz. The quartz is most abundant in the East and the rock there approaches the gneiss. Mica predominates in the West where the rock is broken up and less compact, giving rise to infiltration of water, necessitating the use of timbering.

The rock drills of the present time may be divided into the following three groups, according to the manner of working the drill-bit:

1. Percussion drills with alternating motion.
2. Rotary drill with diamond bits.
3. Rotary drills with steel bits.

The percussion drill with the fore and backward motion works by the weight of the drill being thrown against the rock, exercising thereby such a pressure upon the stone, that its crushing strength is overcome and the rock is pulverized. The drill-bit is made to turn around its own axis and an approximately round hole is made by frequent and quickly repeated blows. The principle of the percussion drill is therefore the great pressure produced by repeated blows.

The rotary diamond drill rotates the bit rapidly and presses it with a low pressure against the rock. The drill-hole is solely made by the grinding and shaving action of the bit. The principle of this drill is based upon the greater hardness of the tool. Diamond drills can never be used under high pressure, as the crushing strength of the diamond is small in comparison to that of other materials. The crushing strength of the rock does not play any part in the work of the diamond drill. This is the reason why they do better work in homogeneous solid rock of uniform structure, than in stratified rock of unequal hardness and consistency, and that they do not work at all in soft ground.

The rotary steel drills—outside of the Brandt drill—are partly imitations of the diamond drills, and operate by spiral steel bits, which are rotated by some mechanical device, being simultaneously pressed against the rock, and producing the hole by the combination of the shaving and pressing action of the boring tool. This kind of drill can be used only in soft material. In hard ground the pressure is not sufficient, and the shaving motion wears off the steel points very rapidly.

The principle of the Brandt hydraulic rock drill is different from any of the percussion or rotary drills. The direct pressure of a percussion drill is not sufficient to overcome the crushing strength of the rock, the *vis viva* of falling masses, the drill bit has to assist the pressure to do the desired work. The mechanical labor is very uneconomically expended in a percussion drill. The idea suggests itself, whether this same amount of labor cannot be applied in a better manner

Mr. Brandt uses in his drill a constant high hydraulic pressure, which presses the tool (drill-bit) with such a force against the rock that the latter is crushed, under all circumstances. As the crushing strength of hardened steel is greater than that of any known rock, the points of the drill-bit—provided the necessary pressure is applied—must also penetrate into the rock. In order that these points always exercise their pressure on fresh ground, they have to be rotated, by which rotation the rock is crushed and broken, but not pulverized and shaved. These two points—high, quiet pressure on hardened steel, and slow rotary motion, to overcome the crushing strength of the rock—form the principles of the Brandt hydraulic drill. The pressure being constant, and being exercised in one direction only, the mechanical labor required is less, and the percentage of work accomplished is greater than in any percussion or rotary drill. It has been proved that the actual useful effect is from three to four times greater in the Brandt drill than in the percussion drills. This makes it possible to use the Brandt drill where too little power is at disposal to employ percussion drills.

The drilling machine proper consists of a cylinder and a piston (Fig. 21); the cylinder carrying the drill-rod. By introducing water, under pressure, into the cylinder, the same, and with it the drill-bit is pressed against the rock. The rotary motion of the drill is imparted by two small hydraulic engines, coupled together under 90°, with differential pistons, and fastened to either side of the cylinder. The valve-motion of these engines is so arranged that the right hand one steers the left hand one, and *vice versa*. These engines turn a worm, and by it a worm wheel, which is connected with the rear end of the cylindrical shell surrounding the pressure cylinder. This shell carries at its farther end the drill-rod, rotates with the worm, and therefore causes the drill-bit to rotate also. The continuous advance of the drill is effected by the direct hydraulic pressure on the cylinder. The cleaning of the drill hole is done by the water, escaping from the hydraulic engine, and led through the hollow drill-rod to the bottom of the hole.

As further illustrating the principles of the Brandt drill the following description is given, reference being had to the accompanying plan:

Fig. 21 is a longitudinal section of the cylinder with the piston and a cross-section of column. The back part of the cylinder is *uninterruptedly* connected with the pressure-water through the port *a*. Now, if pressure-water is admitted through *b* into the other part of the cylinder and the exit at *c* is closed, the cylinder and with it the drill-rod and bit is pressed forward by a pressure corresponding to difference of the areas of the piston. With *b* shut and *c* open, the cylinder moves backward with a pressure corresponding to the annular area of the piston. With *b* and *c* both closed, the cylinder remains stationary. Fig. 22, explains the principle of the small hydraulic engines, turning the drill. The working piston is a differential piston. The forepart of the cylinder is continuously connected with the pressure-water through *e*. The distribution of the pressure-water takes place only in the back part of cylinder by means of a piston-valve. The water used runs off through *a*. Fig. 23 shows the accumulator. The pressure-water is admitted uninterruptedly into the cylinder through the port *a*. If the pumps deliver more water than used, the piston of the accumulator rises above the upper section of the cylinder; allowing the water to escape through *b*. The weight is regulated by the addition of iron plates.

The drill rod consists of a number of longer and shorter sections of a tube, with flat screws at either end. They are quickly joined and disjoined by means of a wrench—much quicker than the change of drills in the percussion—drills.

The shell above mentioned, allows the machine to advance a length of 1.1 ft.; the rod, therefore, must be extended every 0.82 ft.—0.98 ft. of drill-hole. The drill-bit has three, four, or five points, according to the hardness of the rock, which protrude a little beyond its edge, making the largest diameter of the bit 2¾ in. while the cylindrical part of the bit has a diameter of 2½ in. (Fig.). This prevents, effectually, any striking of the drill-rod. The drill-rod and bit being hollow, a core is obtained, giving an exact record of the ground traversed. The mechanical labor of the machine, therefore, is confined to the area represented by this ring, which again is a great saving in power over the percussion drill, where the entire area of the hole must be worked away.

Contrary to the deafening noise of the percussion drills, this drill works perfectly noiseless, only the crushing of the rock under the enormous pressure of the drill being audible.

The whole machine is supported by a column (Fig. 24). This is constructed after the principle of the hydraulic press, with differential plunger-piston. The pressure acts constantly upon the annular space; the opening or closing of the ports *c* and *b*, cause the advance or backward motion of the piston; if both are closed the piston remains stationary. The piston has a diameter of 7¾ in. Deducting the counter-pressure on the annular space, the pressure on the piston is theoretically 51,400 lbs., the water from the accumulator having a pressure of 1220 lbs. per square inch. The piston can move a length of 1 ft., 8 in., it is open at one end, so that the whole column is filled with water, thereby increasing its stability. The weight of each column is 660 lbs., filled with water. The machine can be moved up and down on the column and can be swung around the same horizontally. It is kept in position by a clamp. The hind part of the machine, which remains unmoved and stable during the work, is connected with the clamps by a hinge. By means of a nut the machine can be turned on this hinge and so assume any desired position.

The time required in setting up column and machines ready for drilling is—in good, solid ground—from eight to ten minutes. Four drills are supported by one column. Water being admitted into the column, the plunger is forced against the rock thereby forming a solid abutment. The drills remain attached to the column, unless requiring thorough repairs. The column rests horizontally on a carriage, and is handled by means of a long lever and a counter-weight. After it is brought in proper position, water is turned on and the column is pressed against the sides of the drift. The motors furnishing the necessary power are four Girard turbines (3 used, 1 in reserve) with horizontal axis, and an exterior diameter of 10′ 6″; interior diameter of 9′ 4″. The buckets, 130 in number, are made of steel from 4⅛″ to 13″ wide; they make 160 revolutions per minute, which corresponds to a velocity on the circumference of 69 ft. per second. The turbines drive three groups of four pumps each by means of geared wheels (3:8) and crank-shafts. The piston is a differential plunger with diameters of 1⅞ in. and 2½ in.; the stroke is 2 ft. 2 in.; the speed sixty revolutions per minute, and the quantity of water delivered 0.44 gals. per second. The valves have large passages and therefore a very small lift, only $\frac{1}{12}$ in. The suction-pipe has a diameter a little larger than the large diameter of the plunger, and the pressure pipe one a little larger than the small diameter of the same. The pumps draw only one way, but press in either direction. They take the water from a canal, situated between the foundations, which is fed

* The data for this article are taken from the official publications of the Imperial department of railroads, and the semi-official publications in the papers of the Austrian Society of Architects and Engineers, also from from private letters and reports.

by the tail water from the turbine running the shop. Before it is taken by the pumps, it is filtered through a filter of gravel and brush. In order to have sufficient power, even in case the supply of water should be small, a reserve steam engine of 30-horse power was procured.

The pipes carrying the water from the pumps to the tunnel, unite in one pipe of 2¾ in. diameter, which takes it to four accumulators. The accumulator consists of a vertical iron cylinder with closed bottom, in which a plunger works up and down. At the lower end of the plunger is a large box loaded with stones and sand, the weight of which is regulated according to the pressure required. As soon as the water-pressure becomes greater than this weight, the piston, and with it the weight, is raised, and after having traveled a distance of 2 ft. 8 in., a valve is opened and a portion of the water can run out. In case the drilling should be suddenly interrupted, the rising plunger opens the valve fully, and all the water is allowed to escape. As soon as the drilling recommences, the piston goes down, the valve closes itself, being held in position by a spring, and after a few strokes of the pump the necessary pressure is obtained again. The plunger piston has a diameter of 3⅛ in. The weight to counter-balance a pressure of 1465 lbs. per square inch, is equal to 12,485 lbs. The valve has a diameter of 1⅞ in. and the spring holding it in position exercises a pressure of 2,760 lbs. upon the same. Two sets of accumulators are in use, whereby a better regulation of the pressure is obtained, than if only one of double dimensions were used. The wrought-iron pipes leading the water from the accumulators to the machines, have a diameter of 3¼ in., a thickness of ¼ in. and are screwed together in lengths of 16.5 ft. The joints are tightened by copper rings.

Working cylinder of the hydraulic engines, diameter	2⅞ inches.
Diam. of piston-rod	1¼ "
Length of stroke	2¾ "
Revolutions per minute	120, in softer rock more.
Revolutions per minute of the drill-bit	3⅛
Theoretical consumption of water	.078 gallons per second.
Mean cylinder of drill, diameter	5½ inches.

The pressure upon this cylinder, deducting the counter-pressure upon the annular space, is, with a pressure of 1465 lbs. per square inch, equal to 26,850 lbs. Weight of the whole machine, 550 lbs.; weight of column, 660 lbs. These dimensions are not the same in all machines. Different sizes are made for different work and ground. In softer ground the worm is a double worm, so that the drill rotates twice as fast. The brook Alfenz, with its tributaries, furnishes the only available source of power. Its water-shed above the tunnel-mouth is 1.54 square miles, but none of the tributaries, nor the brook itself reach with their sources into the glaciers and snow region. The water above the tunnel mouth is not sufficient for the power required; therefore the river below and its tributaries have to be made available. The total fall of the upper part is 591 ft.; the lower section of the brook is 1.5 miles long with a fall of 594 ft.

No open flume was possible for the upper line, as the climate is too severe and the land slides too frequent. A pipe line, therefore, had to be laid. Two weirs were built in the two forks of the brook near the village of Stuben. The pipes from these weirs on, have a diameter of 14 in. Below their junction the diameter is 18 in. for the total length to the tunnel-yard. They are made of sheet-iron; in the upper section single riveted, in the lower, double; varying in thickness from ⅛ in. to ⅜ in., to ⅛ in., to ⅛ in., while the 14 in. pipe is all ⅜ in. thick. The single lengths are 20 ft. long and are joined by flanges. They are tightened with rubber rings of ⅜ to ⅝ in. thickness. The total length of the pipe line is 10,000 ft. Taking the minimum discharge, the same can furnish about 250 horse-power. For eight or nine months in the year double that power can be obtained.

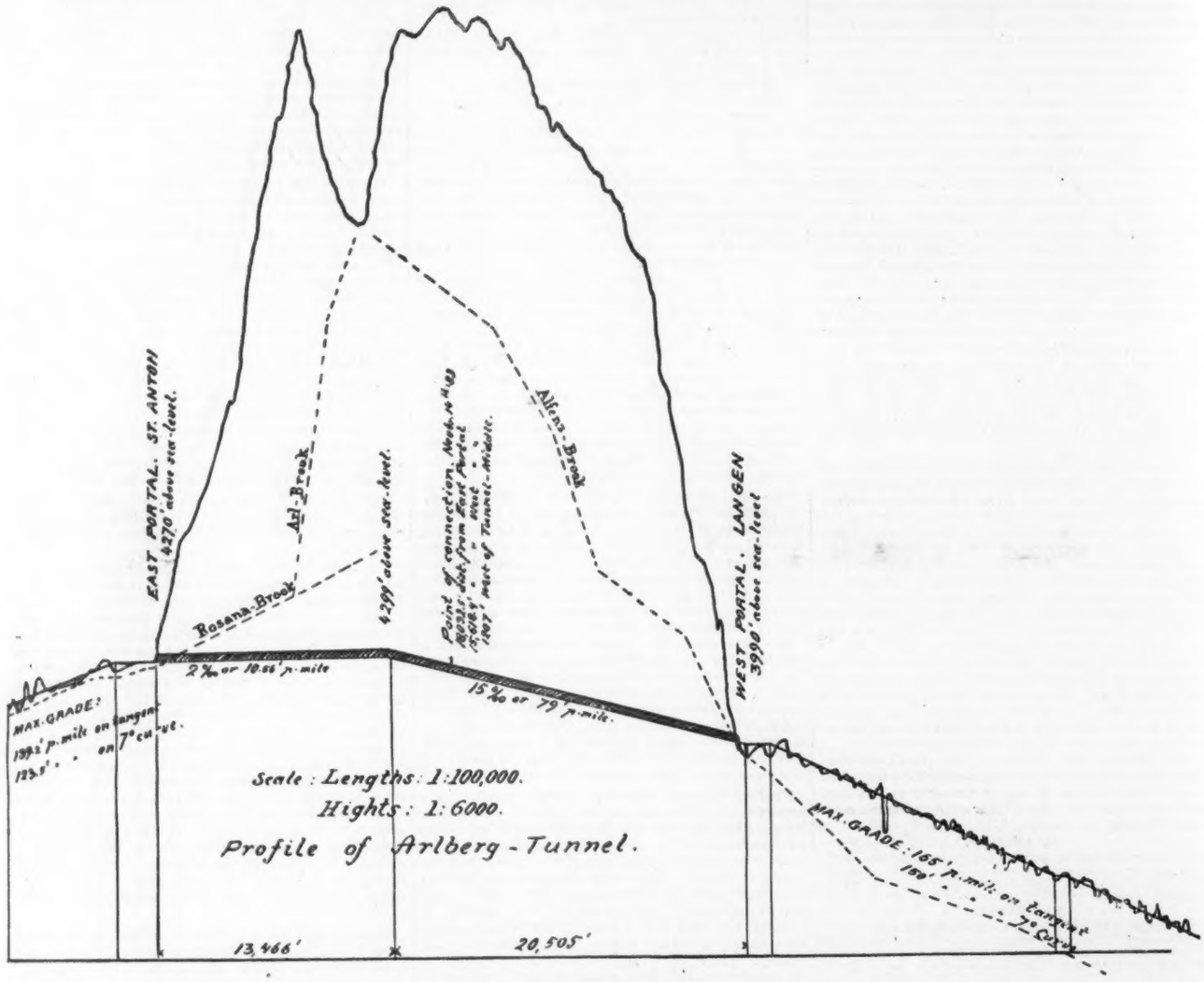
In the beginning a temporary ventilator was erected, driven by a small turbine of about 30 horse-power. For the definite ventilation a new water conduit had to be built. The effective head was 295 ft., furnishing at least 180 horse-power. The least amount of fresh air to be delivered into the tunnel is stipulated by contract to be 5,300 cu. ft. per minute. In order to accomplish this it was necessary, considering the small amount of water, to reduce the resistance in the pipes as much as possible. Therefore the pipe was made 20 in. inside. To furnish the required quantity of air and to secure a sufficient initial pressure for the same, a combination of centrifugal ventilators was used. The air is pressed from the first ventilator into the second, from the second into the third, from the third into the fourth, etc.

The principle of this arrangement, previously ascertained by experiments and trials, is, that the pressure increases in direct proportion with the number of ventilators, provided that the latter are all of the same construction and run at the same speed.

Two sets of such combined ventilators were used, which can either blow into one and the same pipe, or, of necessary, can be so combined, that the first set entirely or partly blows into the second one. By the latter the pressure would be still more increased, and would amount in the fourth ventilator to 40x75 (0.75 lbs. being the initial pressure) =3.00 lbs, in the fifth to 5x0.75 =3.75 lbs., and in the sixth to 4.50 lb. This system, an invention of Mr. Brandt, has never before been carried out to such an extent. The final plant for the ventilator consisted of one Girard turbine of 200 horse-power, from which by means of a counter-shaft, six ventilators are moved. The ventilators are all of exactly the same construction, their maximum speed is over 1,500 revolutions per minute, the turbine making about 128. One group alone making 1,360 revolutions per minute, delivers 3,900 cu. ft. of air per minute; the pressure is then as follows:

In the first ventilator	0.63 lbs. per square inch
" second "	1.26 " " "
" third "	1.89 " " "

In connection with the Brandt drill it has been observed that a very effective purification of the air takes place by a spray of water, obtained from the water pipe


EAST PORTAL. ST. ANTON 4270' above sea-level.
Alf-Brook
Rosana-Brook
4299' above sea-level.
Point of connection. Neuk.m.(1033) dist. from East Portal 10,018'. " " West " 1007' east of Tunnel-Middle.
Alfenz-Brook
WEST PORTAL. LANGEN 3990' above sea-level
MAX. GRADE: 199' p. mile on tangent 123.5' " " on 7° curve.
2 2/10 or 10.56' p. mile
15 2/10 or 79' p. mile.
Scale: Lengths: 1:100,000.
Hights: 1:6000.
Profile of Arlberg-Tunnel.
MAX. GRADE: 185' p. mile on tangent 159' " " " 7° Curve
13,466'
20,505'

PROFILE OF ARLBERG TUNNEL.

under high pressure, by opening a proper valve immediately before blasting. The mere wetting of the debris is in itself beneficial as it absorbs the gases enveloped in the pile of debris.

As previously mentioned, the East-header has been driven by percussion drills. The drills used were the same kind as used at the Gotthard tunnel, namely, the Ferroux Séguin and Welker drills. All these have automatic feed motion, which, according to the unanimous opinion of all the mechanics of the Gotthard tunnel, is preferable to hand-feed when a number of drills are used on one carriage. The automatic backward motion—to withdraw the drill from the hole—has been abandoned of late, being the source of too many delays. The Ferroux and Séguin drills have tappet-valves, while the Welker drill has a valve moved by the compressed air itself, (similar to Ingersoll "Eclipse"). All these have a riffle-bar with ratchet wheel to set the drill, and its back stroke. The shells or cages of the Ferroux and Séguin machines have toothed guides on which the drill moves forward. Welker employs the air-pressure to press the machine against the guides; this pressure is stopped for a short moment at the forward stroke, allowing the drill to advance. The diameter of the cylinder is, in the Ferroux and Welker drills, 4½ in; in the Séguin drills, 3⅞ in. The stroke is from 3⅞ in. to 4¾ in. The drill-bit is chisel-pointed, 2 in. to 1¼in. diameter. The Ferroux drills are now exclusively used.

The drill-carriage is of the same construction as that in the Gotthard; it rests on two pairs of wheels, is entirely of iron and weighs 6,614 lbs. It is capable of receiving 8 drills, which are arranged one over the other, 4 on each side. They can be moved up and down by vertical screws Ten compressors are on the ground; they are wet, double-acting, with plunger-piston of 16 in. diameter, length of stroke, 26 in., making 45 revolutions. Six of these compressors deliver in an aggregate, 534 cu. ft. of air per minute, with a pressure of 73 to 88 lbs. The same can easily be increased to 117 lbs. Two reservoirs of 1,340 cu. ft. aggregate capacity receive the air from the compressors and deliver it to the pipe in the tunnel, which has a diameter of 8¾ in.

The motor consists of two turbines, having an exterior diameter of 11.8 ft. making 45 revolutions per minute, and of 6 water-pressure engines. The brook Rosana, the only available source of power, has a watershed of about 4 sq. miles. At a distance of about 2.5 miles from and 460 ft. above the mouth of the tunnel, the water is taken into a wooden flume of 8.6 square feet area and with a fall of 10.5 ft. per mile. The maximum discharge is 220 gils. per second with a velocity of 4.1 ft.. Four tributaries discharge their water into this flume at different points. The weir and filter-box at the head of the flume are built of timber. The water is collected in a reservoir above the tunnel, from which a 2,700 ft. long pipe, 36 in. diameter and made of soft Bessemer sheet-steel, takes the water to the turbines. The single pipes are 16 ft. long and vary in thickness—increasing with the head—from ¼ in. to ½ to ⅝ in. They are double riveted. Effective head is 432 ft., power obtained 1,700 horse-power. In winter the water supply is so small that not more than one-half of this may be counted upon. The heavy snow-fall requires a con-

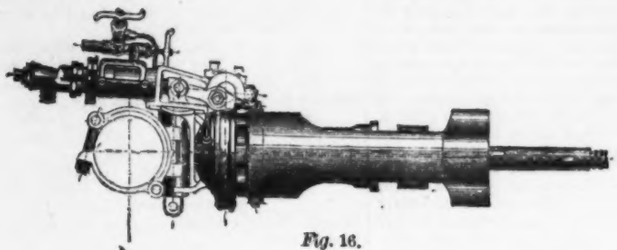


Fig. 16.

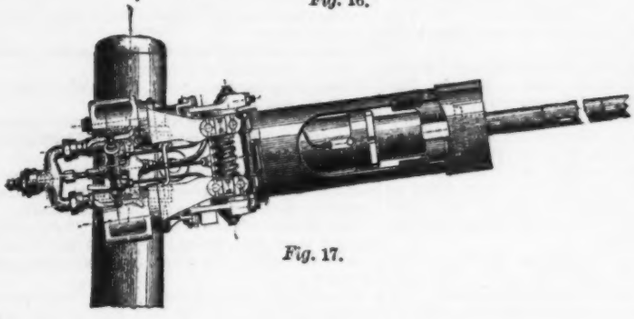


Fig. 17.

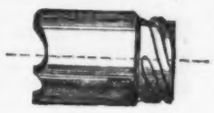


Fig. 18.

Fig. 19

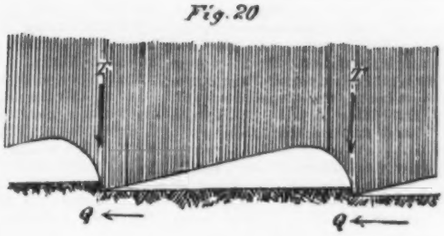


Fig. 20

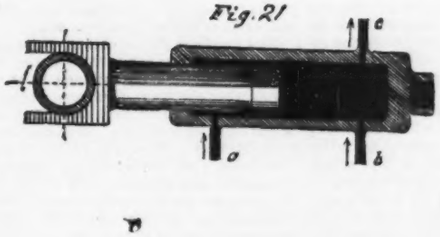


Fig. 21

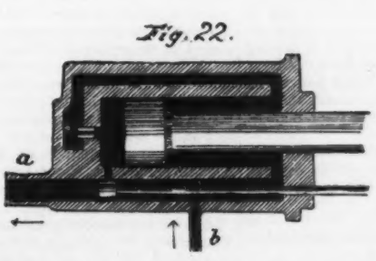


Fig. 22.

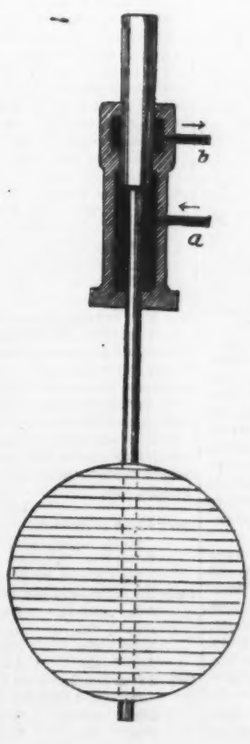


Fig. 23.

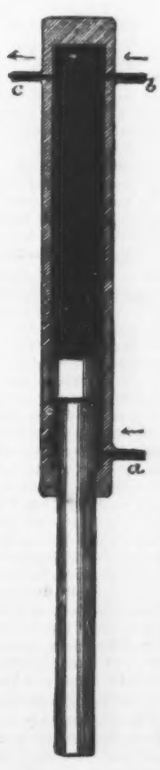


Fig 24.

Fig. 21, 22, 23, & 24 explain the principle of the Brandt-Drill, without reference to detail.
Fig. 21 shows the piston attached to the column, and the cylinder, which carries the drill-rod.
Fig. 22 is a ~~cross~~-section of the hydraulic engine, turning the worm.
Fig. 23 is a section of the accumulator and Fig. 24 of the column.
Fig. 20 shows the teeth of the drill-bit.
Fig. 18 & 19 show the drill-bit.
Fig. 16 & 17 illustrate the Brandt drill of latest construction, as used in the Arlberg-Tunnel.

stant and careful watching of these conduits. Four blowers are used to deliver 6,354 cub. feet per minute into the tunnel through a wrought-iron pipe of 16 in. diameter, driven by four water-pressure engines.

As already mentioned, the nature of the ground in the East and West header was so different that the whole work performed cannot be used to form an idea of the comparative merits of the two different systems of drills.

I shall, however, present here a number of facts which will be of interest and which will enable interested parties to form their own conclusions. Although the progress of the header made (number of feet per month) is not adapted to form an impartial base for a comparison between the two different systems of drills, I shall give the following data concerning it:

During the period of June 24, 1880 to December 31, 1881, the East-header was advanced 6,093 ft., of this were driven by land-labor only 683 ft., and by machine-labor only 5,410 ft. There were 546 actual working days, of which 145 days were used by the hand-labor and 401 by the machine-labor. Therefore we have an average progress per 24 hours by machine-labor of $\frac{5410}{401} = 13.49$ ft. The ground traversed in this period consisted of micaceous slate and gneiss, and was very homogeneous, requiring rarely any timbering. These circumstances enabled a very regular and systematic work, not interfered with by any delays and interruption. Six drills were used in the face. During the same period (June 26, 1880 to Dec. 31, 1881), the west-header was advanced 4,468 ft. Of this were made by hand-labor only..... 1,161 ft.
" " " " " hand and machine-labor together..... 740 ft.
Of this were made by machine-labor only..... 2,567 ft.
There were 529 actual working days in this period, of which hand-labor only occupied 225.60 days; hand-labor and machine-labor together 76.25 days; machine-labor only 227.15 days. The average progress per 24 hours by machine-labor only was $\frac{2567}{227.15} = 11.30$ ft.

The ground traversed consisted of micaceous shale, very much decomposed and disturbed, with a great deal of water, causing heavy pressure. It required a nearly continuous timbering of the heaviest kind, frequently even lagging, driven ahead was necessary. This made a regular systematic work impossible, as the same had to be altered continually according to the momentary requirements. In heavy ground the width of the heading is reduced from 9 ft. to 7.$\frac{75}{100}$ ft. and temporary supports of iron rails are put in. Thereby it is possible to proceed with the machine drilling, while the dip is widened behind by hand-labor and the ground secured by solid timbering. Very often, however, the ground was of such unfavorable character as to make machine drilling entirely impossible. Herein lies the reason for the smaller progress in the West header. The number of machines used in the face were two against six in the East header. Six drills in the east-header made 5,410 ft., or one drill $\frac{5410}{6}$ ft. 901.67 ft.,; two drills in the West header made 2,567 ft.,; or one drill 1,283.5 ft.

Investigating now the single drilling or attacks separately we have the following for the same period:

In the east-header the 5,410 ft. of header required 1,249 drillings or attacks; the average progress made by one attack thereupon, was $\frac{5410}{1249} = 4.$ (ranging from 3.15 ft). Six machines for each attack. In the West header the 3,307 ft. of header, 2,567 X 740 ft. requires 778 drillings; the average progress made by one attack therefore, was $\frac{3307}{778} = 4.25$ ft. (ranging from 3.28 ft.—4.69ft). Two machines for each attack. Comparing the two headers in reference to the length of drill holes, the amount of dynamite and drill-bits required in order to make one running foot of header, we have the following average for the same period as above:

The percussion drill in the East header requires per one running foot of header: 13.$\frac{75}{100}$ lbs. of dynamite, 22.6 ft. of drill holes (2 in. to 1¼ in. diameter) and 17.$\frac{75}{100}$ drill-bits. The hydraulic drills in the West header required per one running foot of header: 6.$\frac{75}{100}$ lbs. of dynamite, 7 ft. of drill holes 2¾ in. diameter and 1.$\frac{75}{100}$ drill-bits. The great differences in the use of dynamite are entirely in some measures due to the different character of the ground in the two headers.

If we now consider the period from September 1, 1882 to June 31, 1883, we have for the East header: Total progress for this period, 5,149.6 ft. in 286 actual working days (*i. e.* total number of calendar days less the time lost by surveying, holidays, lack of water, breakage of pipes or machines, and by such timbering as prevented the usual regular proceeding with machine drilling). The average progress per 24 hours is therefore $\frac{5149.6}{286.5} = 18.0$ ft. The ground traversed during this period was favorable and required but rarely immediate timbering. Mostly it was sufficiently self-supporting to proceed with the drilling without any timbering. Eight drills were used, except during the first nine days of September 1882, when only six drills were employed.

During the same period the West header was advanced 4,873.1 ft. in 282.5 actual working days. The average progress per 24 hours is therefore $\frac{4873.1}{282.5} = 17.25$ ft. The ground traversed during this period was somewhat more favorable than in the point considered above (June 1880—Dec. 31, 1881), but still for most of the time it required immediate timbering or at least immediate temporary supports by iron rails. Four drills were used, except from Septmber 1, to October 13, 1882, and in December 1881, when only three drills were used.

The progress of 5,149.6 ft. in the East header required the work of eight percussion drills, while the 4,873.1 ft. in the West header were made by four hydraulic Brandt drills. The work performed by one machine is therefore as follows: One percussion drill made 643.7 ft.; one hydraulic drill made 1,218.3 ft.; which is a portion of 1 : 1.89.

Investigating now the single drill separately in both headers, we see that in the East header during the period from Sept. 1, to December 31, 1882, 2,028.0 ft. of drift was made; the average progress of each attack was 4.69 ft. The progress in the West header during the same period was 1,728.9 ft. the average progress made by one drilling was 4.26 ft. From January 1, to January 30, 1883 the East header was advanced 3,120.7 ft. the average progress of each attack was 5.10 ft. The West header was advanced in the same time 3,144.2 ft. The average progress of one attack was 4.62 ft. The percussion drills in the East header required during the four months from Sept. 1, to Dec. 31, 1882, in order to make one running foot of header, an average of 37.1 ft. of drill holes, 14.6 lbs. of dynamite, 22.1 drill-bits, while the requirements of the dynamite drills in the West header were: 12.6 ft. of drill holes, 13.1 lbs of dynamite and 8.3 drill-bits.

For the period of six months from January 1, 1883 to June 30, 1883 the same items stand as follows: East header, one running foot of header required, 36.1 ft. of drill holes, 12.82 lbs of dynamite and 19.5 drills sharpened. West header, one running foot of header required 13.75 ft. of drill holes, 12.41 lbs. of dynamite and 9¼5 drill-bits. With the percussion drills one drill made in an average 1.78 feet of drill holes before being so dull that it had to be replaced by another one, while with the hydraulic drill, 1.58 ft. of drill holes required the removal of the drill-bits.

During the month of July, 1883, the ground in both headers was of about an equal character. The East-header had, however, the one disadvantage that it was driven on a down grade, thereby necessitating the debris to be transported up grade.

The total progress of the East header, made by eight percussion drills, was 613 ft., deducting the delays of 20 hours and 45 minutes, we have an average progress per 24 hours of 20.3 ft. The average progress made by one attack was 5.42 ft. One running foot of header required 35.3 ft. of drill holes, 12.15 lbs. of dynamite and 18.5 drills sharpened. One drill before required to be sharpened, made in an average 1.90 ft. drill hole.

On the West side, four hydraulic drills working, the items were as follows: total progress, 641 ft., deducting the delays of 6 hours, the average progress per 24 hours was 20.7 ft. The average progress made by one attack was 5.02 ft.; one running foot of header required 14.1 ft. of drill holes, 12.2 lbs. of dynamite and 8.9 drills sharpened. One drill-bit made in an average 1.54 ft. of drill hole before being too dull. Number of drill holes needed for one attack was, in the East header, 32.12 and in the West header, 13.33. Average time required for one attack (setting up drills, drilling, blasting, removing debris and necessary timbering) in the East header, 6 hours and 39 minutes, in the West header, 6 hours and 17 minutes, of which time the drilling alone took 53.77 per cent. in the East and 52.72 per cent. in the West header. This is an average of several years.

The following is a summary of the work done in the top header on the east and west side of the Ariberg tunnel, from its beginning, June 24-26, 1880, to the 31st of August, 1883.

EAST HEADER.

1880—From June 24 to Nov. 15, exclusively hand-labor 677 ft.
From Nov. 16 to Dec. 31, machine drilling, 6 Ferroux drills, 408 ft.

1881—All the year, 6 Ferroux drills.

Jan.	335 ft.	May	446 ft.	Sept.	450 ft.
Feb.	312	June	356	Oct.	503
Mar.	414	July	406	Nov.	489
Apr.	424	Aug.	385	Dec.	490

1882—From January 1, to August 8, 6 Ferroux drills, after that 8 Ferroux drills.

Jan.	539 ft.	May	487 ft.	Sept.	501 ft.
Feb.	483	June	641	Oct.	474
	(max. daily progress, 26.2 ft.)				
Mar.	536	July	539	Nov.	561
Apr.	519	Aug.	488	Dec.	494

1883—All the time, 8 Ferroux drills.

Jan.	550 ft.	Apr.	594 ft.	July	613 ft.
Feb.	432	May	610	Aug.	637
Mar.	383	June	554		

Total progress in the year 1881....3,010 ft.
" " " 1882....6,282 ft.
" " first 6 mos. 1883....3,123 ft.

Average progress per 24 hours, 1881, 13.75 ft. ($\frac{3010}{219}$), including all delays.
Average progress per 24 hours, 1882, 17.20 ft. ($\frac{6282}{365}$) including all delays.
Average progress for 6 months, 1883, 17.25 ft. ($\frac{3123}{181}$) including all delays.
Average progress for the whole time, 15.82 ($\frac{12415}{785}$) ft. including all delays.
Aggregate time during which the regular progress of the machine-labor was interrupted and suspended: 40 days, 2¾ hours.

WEST HEADER.

1880—From June 26 to Nov. 15, exclusive, hand-labor only, 745 ft.
From Nov. 16 to Dec. 31, machine-drilling, 2 Brandt drills, 256 ft.

1881—All the year 2 Brandt drills.

Jan.	130 ft.	Apr.	212 ft.	July	393 ft. Oct. 329 ft.
Feb.	239	May	337	Aug.	368 Nov 286
Mar.	144	June	359	Sept.	297 Dec. 370

1882—From 1st of Jan. to Feb. 16, 2 Brandt drills, from Feb. 16 to Oct. 13, 3 Brandt drills, from Oct. 13 to Nov. 30, 4 Brandt drills, during Dec., alternately, 2, 3 and 4 Brandt drills:

Jan.	482 ft.	Apr.	441 ft.	July	490 ft. Oct. 491 ft.
Feb.	426	May	446	Aug.	527 Nov. 493
Mar.	455	June	509	Sept.	428 Dec. 317

1883—All the time, 4 Brandt drills.

Jan.	453 ft.	Apr.	525 ft.	July	641 ft.
Feb.	438	May	625	Aug.	486
Mar.	517	June	586		

Total progress in the year 1881.....3,466 ft.
" " " 1882.....5,505 ft.
" " first 6 mos. 1883.....3,144 ft.

Average progress per 24 hours, 1881 ($\frac{3466}{365}$) 9.5 ft., including all delays.
Average progress per 24 hours, 1882 ($\frac{5505}{365}$) 15.1 ft., including all delays.
Average progress per 24 hours, first 6 months, 1883, ($\frac{3144}{181}$) 17.35 ft., including all delays.
Average progress per 24 hours, for the whole time, ($\frac{11615}{873}$) 13.32 ft., including all delays.
Aggregate time during which the regular progress of the machine-labor was interrupted and suspended: 200 days, 20½ hours.

Reducing the total time of 911 days to the time actually employed for machine-drilling by deducting the respective delays, we have the following result:

East Header. (6-8 percussion drills). Total progress, 14,415 ft. in 911 days, less 40.1 days, or in 870.9 days of actual machine-labor; this gives an average daily progress of 16.59 ft.

West Header. (2-4 hydraulic drills). Total progress, 12,115 ft. in 911 days, less 201 days, or in 710 days of actual machine-labor; this gives an average daily progress of 17.06 ft.

The best criterion of the value of any system of drills is the frequency of repairs needed. The experience of the Arlberg Tunnel is as follows:

East Header.—The machines, while under ground are not particularly taken care of: if the least disorder or breakage happens, the machine is at once exchanged for another one, kept in reserve, so that on an average each machine, after four day's service, having made about 330 ft. of drill holes, goes into the shop for repairs, or at least for a thorough cleansing and overhauling. Therefore, 4 or 5 times as many machines must be kept on hand as are actually used in the header. In the West header, the hydraulic Brandt drills are carefully examined and cleaned after each drilling, for which purpose a blacksmith is on the shift, and who is able to repair common damages. The machines remain underground for many months, and one machine performs a work of about 6,300 ft. of bore holes before it needs to go to the shops. Therefore there are only a few reserve machines. During a few weeks in the winter 1880-81—the installation being only half finished—the water supply on the East side decreased to about 150 horse-power, and on the West side to about 60. In both cases this was scarcely sufficient to do the necessary work—the headers being each about 1,500 ft. long at that time—which speaks for itself in reference to the two different systems of drills.

In summing up the experience gained at the Arlberg Tunnel with the different drills, we have the following:

	Percussion Drills.	Hydraulic Brandt Drill.
Proportion between horse-power to do the same work	5	2
No. of machines working in face of advance-header of same size	6—8	2—4
Average number of drill-holes required for one attack	32	13
Total length of drill holes required to make one running foot of header	37 ft.	13 ft.
Lbs. of dynamite used to make one running foot of header	13.7	13.0
No. of drill-bits or drills sharpened per one running foot of header	20.8	8.7
Average progress of header made by one attack	4.71 ft.	4.38 ft.
Average depth of bore-hole drilled by one drill-bit	1.78 ft.	1.58 ft.
Average time for one attack	6 hrs. 39 min.	6 hrs. 17 min.
Proportion of this time occupied by drilling alone	53.77 per cent.	52.72 per cent.
Average length of drill-holes one machine can make without needing repairs	350 ft.	6500 ft.
No. of men required for running the drills in the header	12—16	5—10
Proportion between the number of actually working drills and the number of machines kept in reserve, necessary for continuous work	1:5	1:1

Besides these facts in reference to the subject, a comparison of the respective merits of the percussion and

hydraulic rock drills, I mention the following in resumè, expressing in words what figures show: The Brandt hydraulic rock drill works with a constant pressure, exercised only in one direction. The mechanical labor, therefore, required to accomplish the purpose, is less, and the percentage of work is greater than in any percussion or rotary drill. The operation of the machine is simple, it works entirely noiseless and without dust. The avoidance of all sudden blows, the exceedingly small wear and tear of the machine and drill-bits, and consequently the small number of repairs and extra machines to be kept in reserve, are advantages easily understood by all practical drill men.

The hollow drill-rod gives an opportunity to prospect the ground; it therefore can serve the same purposes as the diamond drill. In cases where sufficient natural pressure can be secured, no machinery, whatever, except an inexpensive accumulator, is needed to work the drills. So, for instance, in deep mines the drills could be directly attached to the water-pipes, doing away with expensive surface machinery. This was done in the mines in Bliberg.

In the appendix to this, I give more data about the Brandt drill, from other places than the Ariberg Tunnel.

(TO BE CONTINUED.)

ABSTRACT OF BIDS.

FOUNDATION CYLINDER FOURTEEN FOOT BANK LIGHT-HOUSE.

Schedule of proposals for the metallic work of the foundation cylinder for the Fourteen-foot Bank Light-house, Delaware bay, opened January 10, 1884:

Jonson Foundry & Machine Co., New York city, $14,974.
Camden Iron Works, Camden, N. J., $17,190.
G. W. & F. Smith Iron Co., Boston, Mass., $17,200. This firm got the contract.
Tanner & Delaney Engine Co., Richmond, Va., $19,900.
Colwell Iron Works, New York city, $19,950.
Phœnix Iron Company, Trenton, N. J., $21,287.
J. B. & J. M. Cornell, New York city, $22,817.
Wallis Iron Works, Jersey City, N. J., $23,283.
Delamater Iron Works, New York city, $24,700.
Rust & Coolidge, Chicago, Ills., $28,270.
Hilles & Jones, Wilmington, Del., $28,947.
Lord, Bowler & Co., Cleveland, Ohio, $31,920.
Henry G. Morris, Philadelphia, Pa., $39,170.
King Iron Bridge and Manufacturing Co., Cleveland, Ohio, $43,709.

HYDRAULIC PASSENGER ELEVATOR, ETC., FOR CUSTOM-HOUSE AT CLEVELAND, OHIO.

The following is a synopsis of bids for hydraulic passenger elevator for the custom house at Cleveland, O:

Crane Brothers & Co., $5,310.
W. E. Hale & Co., $7,564.

The bid of Messrs. Crane Brothers & Co., the lowest, has been accepted.

CUT STONE AT BUFFALO, N. Y.

The following is a synopsis of bids for cut stone for the superstructure for the custom house, etc., extension at Buffalo, N. Y., opened September 10, 1883:

M. A. McGowan, $32,100, buff Amherst.
W. D. Collingwood, $34,950, Amherst, rubbed.
W. D. Collingwood, $35,050, Amherst tooled.
Reinheimer, Ruehl & Co., $36,500, Amherst.
P. G. Straub, $36,900, Amherst.
D. R. & H. Fogelsonger, $36,900, Amherst.
Jacob Veihmeyer, $38,650, Amherst.
Belknap & Dumesnil Co., $43,400, Bowling Green.
Hallowell Granite Co., $44,943, Bedford.
Albert Neukom, $48,000, Amherst.

The bid of M. A. McGowan, ($32,100), the lowest, has been accepted.

STEAM FREIGHT ELEVATOR AT PUBLIC STORES BUILDING, NEW YORK.

The following is a synopsis of bids for steam freight elevator for the public stores building at New York City.

George C. Howard, $4,432.
Otis Bros. & Co., $5,272.
Whittier Machine Co., $5,760.
Copeland & Bacon, $6,660.

The bid of George C. Howard ($4,432), the lowest, has been accepted.

STEAM FREIGHT ELEVATOR FOR ASSAY OFFICE BUILDING, NEW YORK.

The following is a synopsis of bids for steam freight elevator, for the assay office building, New York City:

Copeland & Bacon, $2,466.
George C. Howard, $2,721.
Otis Bros. & Co., $2,725,
Whittier Machine Co., $3,525.

The bid of George C. Howard ($2,721), the lowest formal one, has been accepted.

HARDWARE—BOSTON.

Bids were opened at the Treasury Department on the 11th inst. for hardware for the extension of the post office and sub-treasury at Boston, as follows:

The Hopkins & Dickinson Manufacturing Company, Newark, N. J., $3,495.27.
P. & F. Corbin, New Britain, Conn., $3,616.42.

The New Railroad Mileage of 1883.

According to the *Railroad Age* track-laying has been in progress during the year 1883 in forty-one of the States and Territories on no less than 241 lines, and at least 6,608 miles of road have been added to the railway system in this country, not counting double tracks, sidings or switches. Later returns will probably increase this aggregate slightly, though not materially. While these figures, as was expected, fall short of the record for the three previous years of extraordinary construction, they exceed those of any previous year in the history of the country, with the exception of 1871, when the total was about 750 miles greater than our present figures for last year. The following is a statement of the railway mileage of the United States for the last ten years:

Year.	Miles built.	Total mileage.	Year.	Miles built.	Total mileage.
1874	2,102	72,383	1879	4,721	86,797
1875	1,712	74,096	1880	7,174	91,944
1876	2,712	76,808	1881	9,784	101,733
1877	2,281	79,089	1882	11,591	113,329
1878	2,687	81,776	1883	6,608	119,937

The figures for 1883 are subject to correction.

Allowing for additional returns it is safe to say, therefore, that the total railway mileage of the United States to-day is, in round numbers, 120,000 miles.

The completion of 6,600 miles of railway during the year means the addition of about 33,000 men—an army in themselves—to the host of officers and other employes of our railroad system. It means the expenditure, at $25,000 per mile, of $165,000,000 on these roads alone. This does not include the countless millions of dollars expended and the tens of thousands of men employed in the construction of the large number of new roads on which track has not yet been laid. In fact, the record of track-laying alone gives a very inadequate idea of the activity and money expenditure involved in railway construction during the year. These figures, moreover, do not include the large mileage completed and under way in Canada and Mexico, with which the capital and manufacturers of the United States have had an intimate connection.

In respect to mileage of track laid during the year, Montana leads with 413 miles (all Northern Pacific), followed by Dakota with 409 miles, Michigan with 406, New York with 375, Pennsylvania with 339, Ohio with 326, Mississippi with 305, etc. Pennsylvania shows the greatest number of new lines, 23, followed by Michigan and Wisconsin with 15 each, Ohio with 14, Dakota with 12, Illinois with 10, and so down. The only States and Territories in which no new mileage is reported are New Hampshire, Rhode Island, Connecticut, Delaware, Nevada and Wyoming—6 in a total of 47.

In addition to the above the Canada Pacific, which is a part and parcel of our continental system of railroads, has completed and opened about 700 miles. Great activity has prevailed in Mexico, and as the latter lines were mainly built with American capital and are under the control of American officials, and give the markets of this country unbroken connection with the most wealthy and populous portions of that republic, they are of equal importance to our people as those built within the limits of the United States.

PARTY WALLS.

"The most pressing need of a building law is in the direction of party walls," said Architect Plant. "Property owners are making party-wall contracts as they sell real estate, which are really an incumbrance rather than a benefit. They are practically giving away as much ground as the party-wall owners, for the provisions of the contract are so vague as to be worthless, and the ground so occupied is as bad as wasted; and there is no way of requiring anything better. I know of one party wall contract inthis city that means something. It provides for 'footings' at a suitable depth and of sufficient thickness; a plan of the wall above ground is shown in the contract with height of stories, thickness of walls, and position of chimneys. Then the provision is made that if either party thinks the other dangerously overloading the wall, either by construction materials or goods, the aggrieved party can select experts to determine the matter, and can compel the other party to sufficiently strengthen the wall to sustain the extra weight. This wall is now built and one side of it occupied. When the other party wishes to build, if it does not conform to the specifications, he may order the present owner of the wall to make it perfect or remove it from his land; if it is all right he will pay for his half of it. But there are few such efficient contracts in the city, and when once a party-wall is built it is an expensive job to strengthen or alter it in any way."—*Minnesota Tribune.*

SELECTED MISCELLANY.

CHINESE writers say that India ink was invented 2967 B. C.

A RURAL subscriber sent the following laconic note to the Buffalo *Commercial Advertiser*: "I trusted and busted. Please discontinue."

THERE are 161 cities in Europe in which telephones are in use, having a total of 30,066 subscribers; in Asia there are 7, with 420; in Africa 4, with 240; in America 126, with 47,185; and in Australia 4, with 897. At the head of the list, therefore, stands America, with an average of 374 subscribers in every town, while the average in Europe is only 187.

IT is stated that the mountains of Gellivara in the northern part of Sweden, consist of pure magnetic iron in immense layers of several hundred feet. One of the peaks alone is supposed to contain 260,000,000 tons. Large forests are contiguous, and they are less than 100 miles from the Atlantic. A railroad is to be built, and it is estimated that the iron can be delivered on the sea-cost at a cost of 60 cents per ton.

IN England and Wales there are now upward of 116,000 miles of road maintained at the public expense, the total expense being a little short of £2,000,000 a year. Turnpike tolls, once so important, have become quite insignificent affairs as sources of income, the total amount received last year being only a trifle over £4,000, or less by £1,784 than the actual amount expended in reparing the roads upon which these tolls were levied.

EXPERIMENTS have been made at the Signal Service Station in Cleveland, Ohio, for several months past to see if the wind had any effect on the mercury, and during December observations were taken daily upon two thermometers placed upon the north side of the station, one of which was completely exposed to the storms and the winds, and the other equally exposed to to the cold, but shielded from the wind. The final summing up shows that the exposed thermometer varied but two-tenths of a degree from the sheltered one.

A BRANCH of the Southern Pacific Railroad is partially ballasted with salt. There is a vast bed of salt in the Colorado desert near India, and in laying a track to the salt mines there, says the Los Angeles *Herald*, the builders were obliged to grade the road for 1,200 feet with blocks of beautiful lumps of crystals. The sea, which once rolled over this place, now 260 feet below the sea level, dried up and left a vast bed of salt about 50 miles in length. The quality is superb and the supply inexhaustable. Grasshoppers of enormous size and giant centipedes have here been pickled in the chloride of sodium, and are to-day, after the lapse of centuries, in full size and perfection of shape. This vast salt bed will be very valuable to the reducers of ore in California, Arizona and New Mexico, and can be supplied in boundless quantities.

IT is known in a vague way that enormous sums are spent annually by railroad companies in promoting bribery and lobbying and opposing private-bill legislation in England, but few who are not experts will be prepared for the huge aggregate which a return just issued discloses. In the decade from 1872 to 1882 the total amounts to nearly four million sterling, divided as follows: In promoting bills, £2,502,557; in opposing bills, £807,068; general legal expenses, £615,088; total, £3,924,712. Gas companies have also spent freely, their total amounting to £356,226, while water companies have disbursed £383,936. In the case of gas and water only a small portion was expended in opposing bills, Scotland being nil with respect to gas and Ireland in the same category as to water. The grand outlay is no less a sum than £4,664,874 and this, it must be remembered, does not take into account the expenditure of the oppositions promoted by private and other parties to the scheme of the railway, gas, and water companies, so that the total cost of this class of private-bill legislation must amount to even a much larger sum.—*Gazette.*

THE *Pall Mall Gazette* gives interesting details as to the amount of capital employed in the construction of tramways in the United Kingdom have been published in a parliamentary paper. The total length open in England, Scotland, and Ireland the 30th of June last was 671 miles, the construction of which had cost £9,750,000, or about £14,530 10s per mile, including in some cases the cost of equipment. These figures refer to twenty-eight tramways belonging to local authorities. The 141 lines are worked with 20,122 horses, 117 locomotive engines, 113 belonging to other than local authorities and 2,819 cars. During the year ended June 30, 1883, 205,721,171 were carried over the lines, the gross receipts being £2,211,973, the working expenses £1,752,360, and the net receipts £459,613. A calculation from these figures shows that the number of horses required per mile during the year is thirty the number of horses to a car about seven. The number of passengers to one horse during the same period was 14,696, and the average number of passengers carried by each car during the year was 104,902.

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ON account of the absence, for two weeks, in Michigan and Ohio of our Mr. Geo. H. Frost, the table of contents for volume X has been delayed. It is now being set as rapidly as possible, and will be sent to all our subscribers as soon as printed.

THE sub-committee of the Philadelphia Council, on Municipal Government, has agreed to favorably report an ordinance consolidating the present Departments of Highways, Markets, City Property, Water and Surveys, into a Department of Works.

VERY full reports of the Annual Conventions of Surveyors and Engineers, held at East Saganaw, Mich., and Columbus, Ohio, in the first two weeks of this month, will be found in SURVEYING AND BUILDING NEWS for January. Single copies, ten cents.

ANOTHER International Exhibition is suggested; 1887 to be the time, and San Francisco the place. Californians representing $300,000,000 are said to have undertaken the scheme. They intend to form a guarantee fund of a million and then go to Congress and the State Legislature for appropriations.

ONE of the most rapidly selling books which we have handled for a long time, is Haupt's *Topographer*, very fully described as to its contents in our advertising pages. The price is $4.00, sent post-paid to any address.

THE interesting and valuable paper on "Land Drainage," by D. W. Pampel, C. E., read before the Ohio Society of Surveyors and Civil Engineers, at Columbus, Ohio; also a very witty paper on "Surveying Instruments and their Uses." by F. M. Priest, Bryan, O., read at the same meeting, are published in *Surveying and Building News* for January, ready next week. Price *ten cents* for single copies.

CLEEMAN'S *Railroad Engineers' Practice* is being printed, and as soon as bound will be ready to be sent out. We have fully 100 orders waiting, and the number is increasing daily. It is the "book for the million," and it will grow in popularity as its years increase. It has already been adopted as a text book in several engineering schools, to which it is recommended as the preliminary work to more advanced studies in engineering. Mr. Cleeman is the severest critic of his own book and is bound to have it as perfect as the observation of himself and friends can make it. There will be no delay in sending out the copies ordered as soon as we get possession of them.

WE sincerely hope that the dark days which seem just now to have gathered about the New York, West Shore & Buffalo Railway may be of short duration. We know nothing of the purposes which originally brought it into existance, but suppose these purposes were well founded at the time, and sufficient to warrant the capital expended.

But we do know that as a piece of engineering work it will stand as a model, and that as far as completed each and every detail reflects credit upon that special department. We know of no new road, up to the present time, upon which so much intelligent forethought was expended in the preparation of plans; or so much system displayed in the execution of these plans. Be its future what it may, and the road will certainly have a future, the rules here laid down for the building of a great trunk line will not be lost upon the coming engineer, and the capitalist as well, wherever the end will justify the means.

A New Elevator Safety Appliance.

There is now on exhibition at the Cooper Institute, an elevator, the invention of John Hodges, which certainly possesses most meritorious features. It is a decided departure from the mechanical devices now in use, and is absolute in its action, whether brought into play by the breaking of the rope or "slipping of a belt."

The appliances may be generally described as follows: The first innovation is in the guides, these are heavy iron castingscut into teethat intervals of about 8 inches, resembling a horizontal section of the edge of a circular saw. These teeth do not project beyond the face of the wooden guides; lying loosely in these depressions are heavy iron dogs which fall outward by gravity and form a rack. Below the body of the car are two levers operated by a counter weight; at the ends these levers are provided with wings pointing downward and inward.

The action is as follows: When the car ascends, the dogs are pushed within the face of the guide casting by the upper end of the levers, which pass up close to the guide; and in descending the dogs are pushed in ahead of the car by the slopping wings mentioned above. But if an accident of any kind happens, the counter weight comes into play, the points of the levers are withdrawn towards the centre of the car, and the dogs not being then pushed back, must inevitably catch the car.

The mechanism is simple and inexpensive, and can be easily applied to any car; the rack, of course, would have to be entirely changed, and is simply a heavy casting.

MAYOR EDSON, in his message to the Board of Aldermen of New York, replies to the criticisms on the delay in commencing work on the new aqueduct, by saying that the Commission have felt it their duty to proceed with great caution on account of the importance of the work and the necessity of protecting property holders on the proposed lines. But he points out also the fact that the demand for an increased supply is daily becoming more pressing; that with the 16⅝ miles of water pipe added in the past year, there are now 548¼ miles of distribution system depended upon an aqueduct that is a constant source of anxiety to those having it in charge. He refers especially to the failure last November of a section of the aqueduct near Yonkers.

The condition of the streets of city during the past year was an improvement our previous years. The total appropriation for street cleaning in 1883 was $1,000,000, with $23,000 added by transfer.

PERSONAL.

H. C. LOWRIE, City Engineer of Denver, Col., was in New York last week.

MR. CHAS. E. SPAULDING, a native of Hartford, Conn., died at Aspinwall on the 25th of December last. He had been Road Master of the Panama Railroad.

THE first step in the plan of enlargement proposed for the Worcester, Mass. Free Institute, has been taken, in the appointment of Mr. GEORGE H. WHITE, of Minneapolis, formerly of Grafton, and for the last year resident engineer of the Milwaukee and St. Paul Railroad, as Professor of Civil Engineering.

G. CLINTON GARDNER was elected President of the Buffalo, New York & Philadelphia R. R. Co. on Jan. 14. Mr. Gardner was formerly a prominent official of the Penn'a. R. R. and late General Manager of the Mexican National R. R. Co.

GEORGE DE B. KEIM was, on Jan 14, elected President of the Phila. & Reading R. R. Co., vice Franklin B. Gowen, who declined a renomination. Mr. Keim was born in Reading in 1831, and is the son of General George M. Keim. He graduated in Dickinson College, Carlisle, Pa., in 1849, and studied law with Charles Davis, of Reading, He practiced in Reading and Pottsville for some years, and made solicitor of the Reading Road in 1871. For some years past he had been Vice President.

THE following were elected officers of the Philadelphia Club of Engineers for 1884:

President, William Ludlow; Vice President, J. J. DeKinder; Secretary and Treasurer, Howard Murphy; Directors, T. M. Cleemann, Frederic Graff, Rudolph Hering, Washington Jones, Henry G. Morris.

The first reception of the club will be held Monday evening, the 21st, at the rooms of the Penn Club.

MESSRS. LOCKETT & FULLER are a new firm of Civil Engineers, who have opened an office for general engineering practice in Jersey City. Major Lockett is a graduate of West Point, and has had a very wide experience in engineering, both in the engineer corps of the U. S. Army with the Engineer Corps of the Ex-Khedive of Egypt, and in private practice as a civil engineer. Mr. Fuller's latest engagement was the construction of the Knoxville, Tenn., Water Works, a curious feature of which was the dropping out of the bottom of the reservoir and leaving cavities which led to regions as yet unexplored. Mr. Fuller has repaired the reservoirs and left them in a satisfactory condition. We hope to get some account from him yet of this rather dangerous element of cost to a contractor who undertakes to build water works on the cavernous soil of Kentucky or Tennessee.

The Annual Meeting of the American Society of Civil Engineers.

The annual meeting of the American Society of Civil Engineers was held at the Society House, in New York, on Jan. 16, Vice-President Wm. H. Paine, presiding.

The election of the following officers for the year beginning Jan. 16, 1884, was announced:

President: Don J. Whittemore.

Vice-Presidents: Wm. H. Paine and Joseph P. Davis.

Secretary and Librarian: John Bogart.

Treasurer: J. James R. Croes.

Directors: George S. Greene, Jr., William Metcalf, Theodore Cooper, Fred. Graff, William R. Hutton.

The President-elect made a short address to the members.

The annual reports of the Board of Direction and of the Treasurer and Finance Committee were then read, showing the Society to be in a most flourishing condition; these were followed by reports from the Committees on Tests of Cement and Preservation of Timber.

In regard to the place of meeting of the Annual Convention of 1884, Buffalo, N. Y., was finally fixed upon, and the time of meeting was left to be selected by the Board of Direction.

Capt. O. E. Michaelis offered a resolution to the effect that a distinctive badge be adopted for the use of the members of the Society, and that all members shall wear such badges upon any occasion that may bring them together as a body; its use at other times being optional with the individual member of the Society; this resolution, after considerable discussion, was carried, and the Board of Direction were requested to prepare an appropriate badge.

The Norman Medal for the year 1883 was awarded to Mr. William P. Shinn, for his papers upon "The Increased Efficiency of Railways for the Transportation of Freight," and "How can Railways be made Efficient for the Transportation of Freight; and the Rowland Prize to Gustav Lindenthal for his paper on the "Rebuilding of the Monongahela Bridge at Pittsburgh, Pa."

After a lunch, served in the Society House, the meeting went into afternoon session at about 3 p. m. The first business was the reading of the report of the Committee upon Standard Time, by the Chairman of that Committee, Mr. Sandford Fleming. The report was discussed and commented upon by Profs. Thos. Egleston and De Volson Wood, and by Messrs. Collingwood, Brooks, Michaelis and others. The chief point of the discussion was the easiest method of adapting the time-pieces now in use to the nomenclature of the new standard time. A resolution by Capt. Michaelis, amended by Prof. Thurston, was unanimously passed by the Society, thanking the Committee for its patient and intelligent labor and praying that the Committee be continued.

Prof. Robert H. Thurston called the attention of the members present to the approaching meeting of the British Association of Science in Montreal, and the meeting of the American Association which will follow in Philadelphia immediately afterwards. Due notice of the action to be taken by the Board of Direction of the Society upon the two events mentioned will be given to the members of the Society.

On Wednesday evening a reception was given to the members attending the annual meeting, by Mr. and Mrs. Charles Macdonald at their residence, 247 Fifth Avenue; between the hours of *twenty* and *twenty-three* o'clock, as officially announced in accordance with the new standard time.

On Tuesday morning, about 10 o'clock, the members of the Society met at the Chatham Street entrance to the East River Bridge, and under the guidance of the engineers of the bridge inspected the machinery at the New York end. They then crossed the bridge on the cars, the mysteries of the "grip" being explained to them, en route, by Colonel Paine. At the Brooklyn end, the propelling machinery was next visited and examined.

Leaving the bridge, the entire party then proceeded to the Department of Tests and Experiments of Fairbanks & Co. at 87 Thomas Street, where by invitation of the firm, they had practically exhibited to them the workings of both the large horizontal and the vertical autographic testing machines. Actual tests were made by Mr. A. B. Abbott, the engineer in charge, who explained to the members present the appliances used for making and recording the tests and the principles of the machines.

At 1 p. m. passage was taken to the wharves, etc., of the New York West Shore and Buffalo Railway, on the Weehawken side of the Hudson, and the afternoon was spent in an inspection of the terminal arrangements of the railway. Lunch was served at the new Weehawken Railway Station upon the arrival of the boat.

On Thursday evening at 8 p. m., a reception for gentlemen was held at the house of the Society. It goes without saying, that this meeting was thoroughly enjoyed by all participating.

The following members were present at the annual meeting:

D. J. Whittemore, Ch. Eng. C. M. & St. Paul Railway, Milwaukee, Wis.; Hon. William J. McAlpine, Bay Ridge, N. Y.; James P. Bogart, New Haven, Conn.; William Sellers, Philadelphia, Pa.; William D. Bullock, Asst. City Eng., Providence, R. I.; Thomas D. Lovett, Consulting Engineer, Cincinnati, Ohio.; Benjamin Rhodes, Sup. Suspension Bridge, Niagara Falls, N. Y.; George C. Tingley, Providence, R. I.; F. N. Finney, Gen. Man. Wis. Cent. Railroad, Milwaukee, Wis.; Casimir Constable, New York; C. W. Durham, Pres. Durham House Drainage Co, New York; E. S. Safford, Div. Eng. N. Y. W. S. & B. Ry., Buffalo, N. Y.; Prof. De Volson Wood, Stevens Institute, Hoboken, N. J.; Prof. T. Egleston, Columbia College, N. Y.; Captain O. E. Michaelis, U. S. A., Frankford Asenal, Philadelphia, Pa., C. W. Hunt, New York; C. D. Ward, Jersey City, N. J., H. D. Blunden, Ch. Eng. N. Y. L. E. & W. R. R. New York; Andrew J. Post, New York; John Bogart, *Secretary* Am. Soc. C. E., New York; F. C. Prindle, U. S. N., New York; Geo. H. Bishop, Middletown, Conn.; Theodore Cooper, Consulting Engineer, New York; Charles E. Goad, Montreal, Canada; James Christie, Philadelphia, Pa.; Prof. A. Beardsley, Swarthmore College, Pa.; Joseph R. Richards, Boston, Mass.; James Owen, Newark, N. J.; William R. Hutton, New York; Joseph P. Davis, Vice-President and Ch. Eng. Metropolitan Telephone Co., New York; Martin Coryell, Lambertville, N. J.; C. C. Martin, Superintendent Brooklyn Bridge, Brooklyn, N. Y.; Percival Roberts, Jr., Pencoyd Iron Works, Philadelphia, Pa.; Fred. Graff, Philadelphia, Pa.; F. W. Watkins, New York; Eliot C. Clarke, Ch. Eng. Boston Improved Sewerage, Boston, Mass.; Edward P. North, New York; Charles Macdonald, President Del. Bridge Co., New York; S. R. Opdyke, Superintendent N. H. & N. Co., New Haven, Conn.; A. N. Connett, South Orange, N. J.; Capt. W. H. Bixby, U. S. A., New York; O. Chanute, Kansas City, Mo.; A. W. Trotter, New York; Sandford Horton, Peekskill, New York; L. L. Buck, New York; G. W. McNulty, Assistant Engineer Brooklyn Bridge, Brooklyn, New York; W. J. Haskins, New York; W. W. Wilson, Engineer Water Works, Yonkers, N. Y.; E. E. Magovern, New York; Prof. R. H. Thurston, Stevens Inst., Hoboken, N. Y.; Col. W. H. Paine. Asst. Eng., Brooklyn Bridge Brooklyn, N. Y.; H. M. Wilson, U. S. Geological Survey, Washington, D. C.; N. W. Ellis, New York; F. C. Colling wood, East River Bridge, Elizabeth, N. J.; J. W. Ferguson, New York; W. A. Nichols, Dept. Docks, New York; Thomas W. Jaycox, Leadville, Col.; G. Lehlback, Newark, N. J.; E. B. Dorsey, New York; C. H. Myers, Dept. Pub. Works, New York; J. M. Knap, New York; W. W. Maclay, Dept. Docks, New York; F. A. Calkins, New York; Robert L. Harris, New York; Wm. H. Wiley, New York; J. G. Van Horne, New York; Chas. H. Fisher, Ch. Eng., N. Y. C. & H. R. R. R., Albany, N. Y.; Wm. E. Worthen, New York; T. Guilford Smith, Buffalo, N. Y.; T. C. McCallom, U. S. N., Boston, Mass.; F. Brooks, Boston, Mass.; S. S. Haight, West Farms, New York; George H. Frost, ENGINEERING NEWS, New York; Henry Manley, Boston, Mass.; George S. Greene, New York; J. J. R. Croes, *Treasurer* Am. Soc. C. E., New York; A. B. Paine, Ch. Eng., C. & N. E. R. R., New York; S. H. Shreve, New York; F. O. Norton, New York; Rudolph Hering, Philadelphia, Ca.; F. L. Griswold, New York; E. R. Andrews, New York; Samuel M. Gray, City Engineer, Providence, R. I.; A. M. Wellington, Asst. Gen. Man., M. C. R. R., Guadalajara, Mexico; A. P. Boller, New York; H. Bissell, Eastern R. R., Salem, Mass.; Sandford Fleming, Ottawa, Canada; T. H. McKenzie, Southington, Conn.; D. McN. Stauffer, ENGINEERING NEWS, New York; Col. A. F. Wrotnowski, C. Ch. Eng., Const. Co., Mexico, Philadelphia, Pa.; Arthur Haviland, Plainfield, N. J.; E. D. Leavitt, Cambridgeport, Mass.; Charles E. Emery, New York; George S. Greene, Eng.-in-Chief, Dept. Docks, New York.

VISITORS—T. D. Whistler, New York; G. A. Lynde, Manchester, England.

Convention of Surveyors and Civil Engineers of Connecticut.

A recent call for a Convention of the Civil Engineers and Surveyors of Connecticut proved successful and on the 15th an organization was perfected that will doubtless be a permanent and valuable one. The meeting was held in the rooms of the Bridgeport Scientific Society and was well attended. There were present the following Knights of the Transit: E. P. Augur, Middletown; D. S. Brinsmade, H. S. Whipple, Birmingham; C. M. Jarvis, East Berlin: H. J. Kellogg, J. P. Bogart, D. C. Sanford, S. W. Searle, New Haven; R. S. Hurlbert, West Winsted; R. J. Sabin, Pomfret; Wm. Fuller, Liberty Hill; Hiram Cook, Norwich; J. K. Wilkes, Danbury; J. M. McKenzie, Southington; B. H. Hull, H. G. Scofield, A. F. Spencer, George B. McEwen, Bridgeport. The meeting was called to order soon after ten o'clock and Mr. B. H. Hull chosen temporary chairman with D. C. Sanford Secretary. After an interesting discussion as to the objects of establishing a State Association of Engineers and Surveyors, a nominating committee was appointed consisting of C. M. Jarvis, D. S. Brinsmade and E. P. Augur. Officers for one year were then elected as follows: B. H. Hull, president: A. B. Hill, of New Haven and A. W. Rice, of New Britain, vice-presidents; C. E. Chandler, of Norwich, secretary; D. S. Brinsmade, treasurer. B. H. Hull, E. P. Augur, J. H. Bunce, Hartford, C. M. Jarvis, N. J. Welton, Waterbury, executive committee. A committee was then appointed to prepare a series of by-laws to be presented for adoption at the next meeting. After adjournment subject to the call of chairman of the executive committee a dinner at the Sterling House was served to those present.

THE Architects of Minneapolis are discussing the question of a building ordinance. The city councils are now hard at work in the attempt to frame a concise document that will be satisfactory to both architects and builders. It is predicted that the building operations of 1884 will exceed in the amount of money expended those of 1883.

PROVIDENCE, R. I., REPORTS.

We have received the "Retiring Address" of the late Mayor, Mr. William S. Hayward; the "Sixteenth Inaugural Address" of the present Mayor, Mr. Thomas A. Doyle; the "Third Quarterly Report of the Board of Public Works" and a "Report of the Joint Standing Committee on the City Engineer's Department in relation to the Pollution of the Tributaries of the Providence River."

From these we make such extracts as may be of interest to our readers. Referring to the water works, the late Mayor, Mr. Hayward, says that the lately prevailing opinion among the citizens regarding the deterioration of the Pawtuxet water was not justified by the facts. According to careful analyses of the water, both from the river itself and the distribution system, made by Professor John H. Appleton, of Brown University, "there is no distinct ground for decided complaint of its quality, nor for fear with regard to its use." Professor Appleton has made these tests at intervals of two weeks for nearly eight years past, and submits a report on the condition of the Pawtuxet water, which is printed in full in the report of the Board of Public Works referred to above.

Last November the City of Providence purchased for $7,000,000 the pipes and franchises of the Pawtuxet Water Pipe Company. These works originally cost $10,000,000. The total length of water pipes now laid of all sizes is, since the water works commenced, 175.01 miles, of which 7.9 miles were laid during the past year and 19 71 since January 1, 1881.

The average daily consumption of water in 1883 was 5,024,000 gallons. In 1878 it was 3,295,000 gallons, increasing pretty regularly with each succeeding year. The greatest amount used in any one day in the past year was 7,044,000 gallons.

The total net cost to the city for the construction and maintenance of the water works may be seen from the following exhibit of the receipts and expenditures for the same from February, 1872, to September 30, 1883:

Expended for maintenance	$ 679,219 93	
Expended for construction	5,257,348 89	
Expended for interest, premium and discount	3,206,110 63	
Total,		$9,142,679 45
Received from water rents	$2,293,368 60	
Received from all other sources,	448,283 79	
Total,		$2,741,647 39
Total net cost		$6,401,032 01

A large storage reservoir has recently been constructed at Ponneganset, in Scituate, with a capacity of 600,000,000 gallons. This is intended for supplying the mills on the Pawtuxet during the dry season. In view of the advantages to be derived by the city during a drought from such a reservoir, the city has paid $2,500 for clearing its bed from underbrush, etc.

There have been $2\frac{7}{10}$ miles of sewers built in 1883, making the total length constructed under the present system 47.98 miles. A series of valuable and comprehensive experiments have been made looking to the final disposal of the sewage. The Mayor recommends that the investigations be continued until they embrace full sources of information as to the probable effect of the prevailing winds and currents.

In referring to the government work on the harbor, Mr. Hayward says a channel 300 ft. wide and 25 ft. deep at mean low tide has been secured from Fox Point to the entrance to the bay.

Mayor Doyle, in his inaugural address, mentions that the sale of water has increased from $29,830.41 in 1872 to $284,572.60 in 1883; and judging from the increase, assures the citizens that by 1890 the water works will be self-sustaining.

The Committee on the Pollution of the Tributaries of the Providence River, after reciting the points examined and the results of their inspection, conclude, under advice from the city engineer, that any final plan for sewage disposal will involve the construction of intercepting sewers, and think immediate steps should be taken in that direction.

A New Water Supply for Utica, N. Y.

BY C. F. CARPENTER, C. E., LITTLE FALLS, N. Y.

According to Mr. Croes' statistics, "waterworks were built in Utica by a private company in 1849; the water from a considerable drainage area is collected in two storage reservoirs from which it is distributed by gravity through 30 miles of cast-iron pipe; there are 190 hydrants for which the city pays the sum of $10,000. Date of returns December, 1882."

During the past year there has been much dissatisfaction not only with the quality and quantity of the water furnished, but with the amount of compensation paid the company by the city.

According to an arrangement the city agreed to pay a certain percentage of the cost on all extensions of water-pipe in its streets; and from the fact that this percentage has been paid by the city for a number of years back, makes it all the more binding. Notwithstanding this fact, some of the tax payers came forward, maintained that it was not binding on the city, and referred only to the time when the water-works were first put in.

In view of the inadequacy of the present supply, the increasing population of the city, a resolution was passed by the Common Council ordering a survey and examination to be made of the various sources of supply accessible from Utica, with a view of ascertaining the feasibility of an entirely new system of water-works, and the estimated cost of the same. This work was placed in the hands of J. C. Campbell. C. E., of New York City, whose report was transmitted to the Common Council of Utica, on January 7th, 1884. In regard to where "an abundant and never-failing supply of pure, wholesome, running water" could be obtained, he says: "In examining the source from which the present water-works company collect the water now brought to the city, I could see no way of securing such a supply from their grounds as would meet with your requirements either in quantity or quality." The Mohawk River would furnish the quantity but the quality is objectionable. The Madison county reservoir "stands second in importance as a source of water-supply, for the 56-mile level of the Erie Canal, between Syracuse and Utica," and is therefore out of the question. "A careful examination of the country between Oriskany Falls and Clinton, showed no ground where a storage reservoir could be constructed at moderate cost, and without interfering with the supply of the Erie Canal and the vested rights of the parties owning mills on the stream below. Burchard's creek which flows into the Oriskany creek near Deansville, Oneida county, is promising, but a large number of manufacturing establishments on the Oriskany creek could bring action against the city for diversion of water. The drainage area is about 28 square miles, the quality of the water fair, and with proper storage reservoirs would yield a supply of 15,000,000 gallons per day. The estimated cost to bring 5,000,000 gallons of water daily from the stream to the city is as follows:

Land for reservoirs, 370 acres at $200,	$ 74,000.00
Storage reservoirs	125,000.00
Distributing reservoir	60,000.00
$11\frac{3}{5}$ miles of cast-iron pipes, laid	260,000.00
Total	$520,000.00

Mr. Campbell, in his report, then states: "After a careful study of the whole subject, I became satisfied that the West Canada creek would furnish a supply of water as called for.

"This stream having its most easterly source in the Adirondacks, about 40 miles north of Palatine Bridge, is fed from numerous lakes on the elevated water shed, between the Sacandaga and Moose rivers, flows westerly about 50 miles over a granitic formation to near the village of Prospect, situate about 16 miles north of Utica; at this point it turns to the southeast and passing over Trenton Falls, joins the Mohawk near Herkimer. The drainage area of the stream above Prospect being about 240 square miles. Above Prospect for about seven miles, the country through which it flows is sparsely settled, and beyond this to its source is uncultivated and covered with a dense forest." At Gang Mills, about two miles above Prospect, it was estimated that about 35,000,000 gallons per day represented the flow of the stream in the summer of 1881, the dryest time known during a period of 35 years.

An analysis of the water of this creek by Prof. Chandler, of New York, taken from the stream about 1,000 miles above the dam at Gang Mills, gives the following result:

Analysis of one United States gallon, 231 cubic inches, appearance clear, strong, yellowish brown, when heated heated to 100° F., woody.

	Grains.
Chlorine in chlorides	0.0245
Equivalent to sodium chloride	0.0405
Phosphates	Faint trace.
Nitrates	None.
Nitrogen in nitrates	0.0322
Free Ammonia	0.0023
Albuminoid Ammonia	0.0059
Oxygen absorbed at 80° Farnh't { in 15 minutes	0.2050
Oxygen absorbed at 80° Farnh't { in 4 hours	0.3370
Hardness equivalent { before boiling	1.4000
to carbonate of lime. { after boiling	1.2770
Oxygenic and volatile matter (loss on ignition)	0.9910
Mineral *Water	1.9250
Total solids dried at 230° Farnh't	2.9160

A comparison is also made of this West Canada creek water with Croton water and with the Utica City reservoir water as follows:

Water, Where from.	Inorganic Matter.	Organic and Volatile Matter	Total.	Hardness.	Authority.
Croton Water, average of 53 ex'ms in 1876	3.155	0.980	4.126	1.845	**Wallen
Croton Water, average of 52 ex'ms in 1877	3.257	1.083	4.330	1.910	"
Utica City Reservoir Water, taken Dec. 25, 1883	4.899	2.508	7.407	2.867	Chandl'r
West Canada Creek Water, taken Dec. 10, 1883	1.925	0.991	2.916	1.400	"

** Ellwyn Wallen, Ph. D., Chemist, New York City.
* Mineral Matter (?)

An engineering party was placed in the field under charge of Colonel Berthoud, to ascertain if the waters of this creek could be brought to this city at a reasonable cost. Mr. Campbell then says in his report: "The next question was, what amount of, water shall be provided for and how much will be required daily for the next ten years, or rather what will be the amount that the works as first constructed should be capable of bringing into the city daily. I believe the best criterion for this is other near-by cities whose water-works have been brought into use within the last ten years." In this connection he cites Rochester and Yonkers as examples. "It is proposed, if water is taken from this stream, to build a stone dam about 2,000 feet north of the iron bridge at Prospect. At this point the low water in the creek is 1117.5 feet above low tide in the Hudson River at Albany, and the spillway of the dam 1127.5 and 743.5 feet above low water in the Mohawk River at the foot of Genesee street.

"The dam as estimated for will be 330 feet in length on top, the spillway 225, and 20 feet above low water. The wings or end walls to be carried up 8 feet above the spillway; the foundation ends of the dam are solid rock. The masonry laid in hydraulic cement, with cut stone on the face and coping; the walls 8 feet thick on top and 18 feet in thickness on the bottom. The dam will back the water up stream one mile; the pond will hold 100,000,000 gallons.

"An abundance of good building stone and sand in the immediate vicinity, and a solid rock foundation, makes it possible to get first-class work at moderate cost.

"The water to be taken out of the east end of the dam through a pipe 24 inches diameter and carried along the east bank of the stream about 2,700 feet, where it is proposed to cross to the west bank on an iron bridge of 150 feet span, thence down the stream to a point 5,000 feet from the dam, where the pipes are reduced to 20 inches diameter.

"The estimate of cost at this point includes 1,200 cubic yards of dry wall to protect and sustain the pipes for the first 1,000 feet after leaving the dam.

"When rock is encountered in excavation for the pipes, the estimate is for width sufficient for two pipes.

"It is proposed to cross the valleys of the Cincinnatus and Nine Mile creeks, and generally other small streams, by laying the pipes beneath the bed of the streams and surrounding them with concrete, as being more safe during freshets. Provision is also made for suitable blow-offs and self-acting air valves.

"The summit of the Deerfield hills is reached, 56,900 feet distant from, and 188 feet below, the spillway of the dam at Prospect. From the summit the line continues southeasterly to the junction of the Deerfield road with the road to Utica and near the easterly line of the town of Marcy, 78,000 feet distant from the proposed dam and 15,560 feet distant from the south side of the Mohawk River at the foot of Genesee street.

"At the point of junction of the Deerfield road it is proposed to construct two reservoirs, each holding 35,000,000 gallons, the surface of the water of the reservoirs to be 300 feet above low water in the Mohawk River. The estimate covers the cost of land for the two reservoirs, but only for the construction of one at present. The estimate is for one 600 feet square, 15 feet deep, and is based on excavating 9 feet, the excavated material used in raising the banks to the proper height; the bottom and sides to be puddled; the bottom covered with gravel, and the sides lined with a slope wall laid in cement mortar; also gate-house with two inlet and two outlet pipes and waste weir, all of first-class masonry; screens, gates and fixtures, a drain-pipe and sewer; also a house for the keeper. From this reservoir a 20-inch main to be laid along the road through Deerfield Corners to and across the Mohawk River to the foot of Genesee street.

"Estimated cost for a daily supply of 5,000,000 gallons delivered on the south side of the Mohawk, at the foot of Genesee street.

Dam at Prospect	$ 30,000 00
Pipes and Laying to Reservoir	343,345 00
From Reservoir to south side of Mohawk	63,426 00
Right of way and damages for same, 90 acres	1,500 00
Land for reservoirs	2,500 00
Compensation reservoirs	20,000 00
	$474,271 00

"At the present time there are 33.83 miles of pipes laid in the streets of Utica for the distribution of water of quantities and sizes, as follows:

8,623	lineal feet of	12	inches	diameter	1.63 mi.
9,300	"	" 10	"	"	1.76 mi.
20,400	"	" 8	"	"	3.83 mi.
72,200	"	" 6	"	"	13.68 mi.
43,721	"	" 4	"	"	8.28 mi.
24,361	"	" 3	"	"	4.61 mi.
178,612	lineal feet in all				33.83 mi.

"There are 225 hydrants to the city with barrels of three and four inches diameter connected with mains by four inch pipes."

It is proposed, and in the following an estimate is made for an entirely new distribution system consisting of 40 miles of pipes, including cost of the pipes and laying them complete, and for 428 case hydrants and 192 stopcocks with boxes and covers placed, the pipes to be suitable for a distribution under a head of 300 feet and laid with the top of the pipe four feet six inches below the surface of the streets, including the taking up and restoring the pavement as follows:

2,400	lineal feet of	20	inch	pipe	@ $4.40	$ 10,560 00
3,100	"	" 16	"	"	2.76	8,560 00
11,000	"	" 12	"	"	1.80	19,800 00
2,700	"	" 10	"	"	1.42	3,834 00
52,000	"	" 8	"	"	1.10	57,200 00
80,000	"	" 6	"	"	.78	62,400 00
60,000	"	" 4	"	"	.52	31,200 00
						$193,550 00

Add for extra cutting of pipes, for branches and special castings estimated to be

5 per cent. on the distribution	$ 5,971 00
428 case hydrants 4 barrels @ $50 each placed	26,400 00
192 stopcocks	5,226 00
192 stopcocks and covers placed @ $25	4,800 00

The summary of all the items, gives:

Estimated cost of dam	$ 30,000 00
" " between dam and reservoir	343,345 00
" " of reservoir	69,963 00
" " between reservoir and city	63,426 00
" " of right of way	15,000 00
" " of land for two reservoirs	2,500 00
" compensation for reservoirs	20,000 00
" cost of distribution	236,047 00
	$772,281 00
Add for superintendence and contingencies 6 per cent	46,337 00
Total estimated cost	$818,618 00

The above figures are as they are given in Mr. Campbell's report, but upon inspection the extension and footings will not be found correct in every case, the errors tending to increase the total sum nine or ten thousand dollars.

Rochester Water Works referred to, cost $3,313,748, and in April, 1882, had 121.5 miles of pipe laid.

Yonkers Water Works cost $702,000, and in Dec., 1882, had 24.5 miles of pipe laid.

Proposed works in Utica estimated to cost $818,618, and is to have 58 miles of pipe laid.

The sample of water analyzed was "taken from the stream 1,000 feet above the dam at Garey Mills," between this point and the sight chosen for the reservoir is a village of about 200 inhabitants, all the sewage and refuse from which, as well as the saw dust and waste from the saw mills is turned into the West Canada Creek, but a short distance above the "setting reservoir" of the proposed water works.

It would have been as well to have obtained a sample of water from the creek on the site of the proposed dam, for analysis, as well as from the stream above these sources of impurity.

Mr. Campbell gives the drainage area as about 240 square miles; I am inclined to think he has underestimated this item by at least 100 square miles; an inspection of a map of the Adirondack wilderness will show that 350 square miles more nearly represents the drainage area of the West Canada Creek above Prospect.

He also gives 225 feet as the length of spill way; theoretically for the assumed 240 square miles, the flood volume not to reach over 6 inches below the top of the wing walls of the dam, would require a spill way 293 feet long. Or with drainage area as assumed length of spill way 225 feet, the water at highest flood would stand 8.9 feet deep on the crest of the spill way, in other words it would be $2\frac{9}{10}$ feet over the top of the wing walls of the dam.

In the above estimate of the cost to the city no mention at all is made of the existing water works. In view of the fact that they have a contract with the city of at least 34 years standing, some calculation should be made in such an estimate what it is going to cost to get out of way. In order to get an approximate of the value of these works I find that Holyoke, Mass., has 27.4 miles of pipe, (Utica has 33.8 miles) and a water supply by the gravity system (similar to Utica).

The cost of the work was	$336,446,00
Estimated cost of new works for Utica	818,618.00
Grand total	$1,155,064 00

TRADE PUBLIATIONS.

"A NEW STATISTICAL AND RAILROAD MAP OF MEXICO AND THE NORTHERN FRONTIER" (71x50 inches). J. L. Smith, publisher, Philadelphia, Pa., 1884. Price $5 to $11.

Now, when Mexico, and all that relates to it, has become a matter of interest and almost daily enquiry among engineers and business men in the United States, a large and reliable map of our near neighbor is among the things desirable. This one shows the topography of the country, the location of actual and proposed railroads, the steamship, cable and telegraph lines, towns and cities, with their respective population, etc. The products of the different zones are also marked upon the map, whether agricultural or mineral. It is well printed, plain in its lettering and figures, and from all external evidence shows hard and conscientious work on the part of its compiler, Mr. A. K. Owen, C. E.

A very important adjunct to this map of Mexico, especially so to the engineer, is a table of altitudes, in book form, compiled from the latest attainable authorities, and showing in metres and Mexican varas the elevation—presumably above sea level though not so stated—of over one thousand points in the Republic; giving the State in which the place is situated, and the authority in each case for the figures named.

OBITUARY.

STRICKLAND KNEASS, late assistant to the President of the Pennsylvania R. R. Co., died at his residence in Philadelphia, Pa., on Monday, Jan. 14, of heart disease. Mr. Kneass, the son of Wm. Kneass, for many years engraver for the U. S. Mint, and a brother of the late Samuel H. Kneass, C. E., was born in Philadelphia, July 29, 1821. His first experience as an engineer was on the Delaware and Schuylkill Canal and on the Philadelphia & Wilmington R. R. He afterwards entered the Renssalaer Polytechnic Institute, at Troy, N. Y., where he graduated in 1839. He then became assistant engineer and topographer on the Penn'a. State survey for a railroad between Pittsburg and Harrisburg, laid out the city of Altoona, Pa., and had charge of the construction of the shops and other improvements of the Penn'a. R. R. Co., at that place. He was at one time a draughtsman in the Government employ at Washington. In 1855 he became Chief Engineer and Surveyor of the newly consolidated city of Philadelphia, and held this office until 1872, when he resigned to accept the position he held at the time of his death.

Mr. Kneass was a member of the American Society of Civil Engineers, elected in 1868, and was President of the Civil Engineers Club of Philadelphia for the year 1881.

AFTER a year's illness, CHARLES LE GRAND MCALPINZ died on the 11th, at his residence, No. 467 Fifth avenue, in the fifty-seventh year of his age. He was one of the older members of the American Society of Civil Engineers, and a brother of the well-known engineer, William J. McAlpine. Mr. McAlpine was a native of Albany, and received the greater part of his eeucation at the Albany Academy, and, although an extensive traveler, had lived the greater part of his life in New York City. He was a quiet and unpretentious man who was well-known among his fellow-engineers as being very careful, consequently his advice and judgment were often sought. He was for a long time principal engineer of the New York State canals; he also superintended the building of the old Harlem bridge and the Chenango Extension. His last important charge was the building of the Raleigh and Seabord Railroad in North Carolina, and it was there that he contracted the disease which proved fatal. Mr. McAlpine leaves only a widow, the daughter of the late Judge Thomas Farrington, of Tioga county.

CORRESPONDENCE.

CANTILEVER BRIDGES.

Special Correspondence Engineering News.

DEPARTMENT OF CIVIL ENGINEERING,
UNIVERSITY OF PENN'A.,

PHILADELPHIA, Jan. 11, 1884.

EDITOR ENGINEERING NEWS.—If you desire to publish it, the literature of Cantilever Bridges may be further enriched by the accompanying description and data, which I collected last summer while at St. Paul, of the road bridge over the Mississippi at Fort Snelling.

On the 29th of March, 1878, Ramsey county voted $100,000 in bonds towards the expenses of the proposed bridge, and a commission was appointed, of which Wm. Dawson was President, and Thos. Cochran, Jr., Sec'y. The U. S. Government also appropriated $55,000 for the bridge, that being one-half of the cost as estimated by the U. S. Engineers.

On April 4, 1878, Mr. Jos. S. Sewall, then engineer of St. Paul, was chosen to make surveys, and on the 14th of the same month he was elected engineer of the work. The plans were completed on July 6th, 1878, and forwarded to the Sec'y of War for approval, and by him referred to a commission composed of Gen'l Alfred H. Terry and G. K. Warren, by whom they were approved.

Bids for masonry (10) were opened Aug. 5, and on the 9th that part of the work was let to Michael O'Brien of St. Paul, who was to complete it by Dec. 1, 1878, but in consequence of a change made in the depth of the foundation of the pier on the Ft. Snelling bank, the time was extended to June 1, 1879, and the cost was increased $15,000. The total cost of masonry when completed, June 30, was $63,397.98.

Bids for the superstructure, which were opened Sept. 30, 1878, varied from $39,444 to $69,000. The plan accepted was that of Horace E. Horton & Co., of Rochester, Minn. for $44,328.

The general design of the trusses is that of the stiffened triangular, as is now clearly illustrated in the accompanying figure.

There are three main spans, the longest of which contains the cantilevers, and five short spans arranged in the following order:—Beginning at the Ft. Snelling end the first span is 135 ft. long, 25½ ft. deep, supported by the abutment and stone pier; the second, is 270 ft. long and 26.6 deep, supported on stone piers: the third is 180 ft. long, 26.5 deep, stone piers; these are succeeded by 5 short iron trusses of the Pratt type, 72½ ft. span and 12 ft. depth, resting on iron piers.

The contract for the superstructures was signed March 11, 1879, and the work completed and accepted March 15, 1880. The cost was:

For Stone Work	$63,397 98
For Superstructure	45,359 53
For Engineering	6,631 38
For Testing	637 54
For Roads and Approaches	11,690 93
For Commissioners' Fees	1,908 00
For Secretary	800 00
For Incidentals	4,500 47
Total	$134,925 80

WM. DAWSON,
WM. LINDEHÉ,
R. KNAPHEDE,
THOS. COCHRAN, JR.,
} Commissioners.

Very truly yours,
L. M. HAUPT.

Railroading in South America.

Special Correspondence Engineering News.

NEW ORLEANS, LA., Jan. 4, 1884.

EDITOR ENGINEERING NEWS:—Please give me some information about railroading in Argentine Republic, in your paper, and oblige,

W. SENS, C. E.,
Hotel Chalmette, New Orleans.

[We have published occasional notes of work in the Argentine Republic, in our "News of the Week" column, to which we must refer our correspondent. All we know is there.—ED. ENG. NEWS.]

ATTACHMENT FOR SCREW DRIVERS.

Special Correspondence Engineering News.

81 WOOD ST., PITTSBURG, PA. Jan. 5, 1884.

EDITOR ENGINEERING NEWS.—I noticed in the issue of your paper for Dec. 29, 1883 under the head of Building Notes, a reference to "the difficulty encountered by carpenters, cabinet-makers artisans generally, in with drawing a screw from work, by the screw turning around under the application of the driver, and refusing to come out of its place, etc."

And the suggestion of the London *Builder* of the application of a heated poker or some such instrument to the screw, and the dipping screws in oil previous to driving, to prevent or defer oxidation. Permit me to offer anot her plan for removing screws from old work and likewise for inserting screws generally in wood or iron work. It consists of a simple attachment attachable to any and all screw-drivers now in use which will grasp the head of a screw and hold the driver and screw head together with sufficient force to draw the screw from its place in old wood, however badly the wood may be oxidised or the matrix worn. I have used the above device for the past year and find it perfectly effective and satisfactory under all circumstances. I have patented my device as you will observe by the papers and drawings which I herewith enclose to you.

Respectfully yours
C. W. DRAKE.

[The patent is No. 290,218, dated Dec. 18, 1883.—ED. ENG. NEWS.]

The American Society of Civil Engineers.

Special Correspondence Engineering News.

AKRON, OHIO, Jan. 10, 1884.

EDITOR ENGINEERING NEWS.—I would like to know when and where the next meeting of the American Society of Engineers will be held, and whether a non-member can secure a copy of the published report of the proceedings. Presuming that the information would be of interest to many engineers throughout the country, I would be pleased to have a reply through your columns.

Yours Respectfully,
C. R. KNIGHT.

[We give report in full of annual meeting this week. The official report can be obtained only by members, except by courtesy of the Secretary, who is always ready to respond to requests from any person, where such requests do not conflict with the rules of the Society or its interests.—ED. ENG. NEWS.]

Finding Deflections for Sub-Chords.

Special Correspondence Engineering News.

RICHMOND, KY., Jan. 11, 1884.

EDITOR ENGINEERING NEWS.—The following rule is an old one and used by many engineers for finding the deflection for sub-chords on R. R. chords, viz: *Multiply the degree of the curve by three-tenths (.3); then this product by the length of the sub-chord in feet:* the result will give the deflection in minutes.

Ex: What is the deflection for 56' in a 6° curve?

ANS: 6°×.3×56'=100'.8=1° 40'.8.

Will some of your readers explain the "why and wherefore" of this, and oblige

A SUBSCRIBER.

COMPLIMENTARY.

Special Correspondence Engineering News.

WEEHAWKEN, N. J. Jan. 14, 1884.

EDITOR ENGINEERING NEWS.—Enclosed please find my subscription to ENGINEERING NEWS AND AMERICAN CONTRACT JOURNAL, for the year 1884. In connection with this I wish to acknowledge the satisfaction I experience in being able to say that although I have necessarily caused you to change the address of my NEWS, *five* different times during the year that is passed; viz: Hyde Park, N. Y.; Portland, Oregon; Providence, R. I.; Jersey City and Weehawken, N. J. I have not failed to receive every copy in good season.

Very truly
GEO. M. FRANCIS.

A BOOK ON MASONRY.

Special Correspondence Engineering News.

NORWOOD PARK, ILLS., Jan. 6th, 1884.

EDITOR ENGINEERING NEWS:—Can you induce Mr. Haupt, or some other reliable engineer, to get up a thorough, practical work on masonry, covering arches, skew-arches, retaining walls, abutments, piers, etc., for single and double track, also for city and town bridges, etc., with complete working drawings for different spans, etc., with cost, as near as may be, of same? As no book or work specially on masonry, has ever been published, it would sell like hot cakes. Yours truly,

D. C. DUNLAP.

[Hasley's little book on Masonry covers many of the above requirements. It is the best there is. Advertised elsewhere.—ED. ENG. NEWS.]

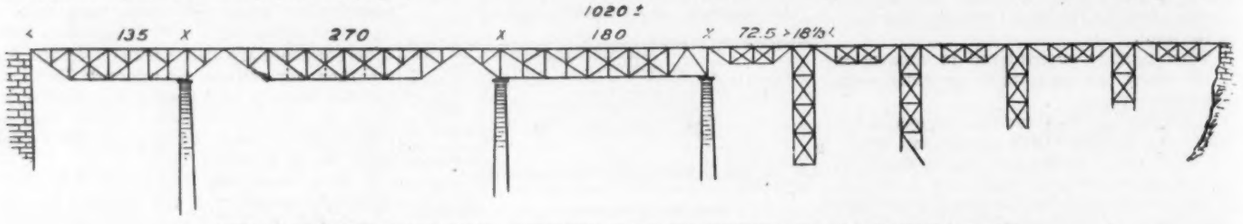
STONEWALL'S BRIDGE BUILDER.

Special Correspondence Engineering News.

RICHMOND, VA., Jan. 15, 1884.

EDITOR ENGINEERING NEWS.—I notice in ENGINEERING NEWS of Jan. 12, page 22, an article under the above heading, credits certain work to "Miles." The gentleman you refer to is Capt. C. R. Mason, of Staunton, Augusta county, Va. He is now, and has been for many years, the principal R. R. Contractor in this part of the country, and from him can be had a true version of the story which in the main is correct.

Very Truly,
CHANNING M. BOLTON.



GENERAL ELEVATION OF THE HIGHWAY CANTILEVER BRIDGE OVER THE MISSISSIPPI AT FORT SNELLING, MINN.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.; M. INST. C. E.

(*Continued from page 21*)

DLXXXIV.—EASTHAMPTON, MASS.

Easthampton, Mass., in lat. 42° 18' N., long. 72° 47' W., is in the valley of a small stream emptying into the Connecticut river. It is a manufacturing village.

Water-works for fire protection only, were constructed in 1873. About 2 miles of 4 and 6 inch cast iron pipe are laid in the streets, with 25 hydrants. The pipe is connected with a Fales & Jenks steam pump in one of the factories, and on an alarm of fire the pump is run at such speed as to give a pressure of 100 lbs. in the pipes. The statistics of cost are furnished. The population in 1880 was 4,316.

DLXXXV.—PLATTSBURG, N. Y.

Plattsburg, N. Y., in lat. 44° 42' N., long. 73° 25' W., on Lake Champlain, at the mouth of the Sananac river, is on elevated and broken ground. It was settled about 1750.

Water-works were built by the city in 1870, taking their supply from mountain streams about 6 miles from the town. A dam across a stream forms an impounding reservoir from which the water is conveyed through 4 miles of 10-inch cast-iron pipe to the distributing reservoir which holds 3,000,000 gallons at 200 feet above the town and 2 miles from it. The water is conveyed to the town in a 12-inch pipe. Distribution is by 15 miles of cast-iron pipe of 12 to 2 inch diameter with 65 fire hydrants and 50 gates. The number of taps is not given. The daily consumption is 500,000 gallons.

The population in 1880 was 5,245.

The works cost $180,000. The expenses of maintenance in 1881 were $3,031 and the receipts, $15,231. The works are managed by three Water Commissioners. D. C. Boynton is the Superintendent.

DLXXXVI.—WASHINGTON, N. J.

Washington, N. J., in lat. 40° 45' N., long. 75° W., is in a hilly country.

In 1882 water-works were built by a private company, taking the supply from Brasscastle creek, on the eastern slope of Scott's mountain, about 3 miles from the borough. A dam across a ravine forms a small impounding reservoir. Distribution is by 5 miles of cast-iron pipe of 10 to 4 inch diameter, with 30 fire hydrants and 60 taps.

The population in 1880 was 2,142.

The works cost $32,000. No further information can be procurred. Daniel Vliet is Secretary of the company.

THE Dedham, Mass., Water Company has declared a dividend of 2½ per cent.

Public Buildings, etc.

Bills have been introduced into Congress, during the week ending the 9th, for erection of public buildings, &c., at the following places:

Portland, Oreg.
El Paso, Tex.
Los Angeles, Cal.
Savannah, Ga.
Fort Dodge, Iowa.
Fort Scott, Kans.
Wichita, Kans.
Sub-treasury, Louisville, Ky.
Floating hospital, New Orleans, La.
Light-house at Mandeville, Lake Pontchartrain.
Bay City, Mich.
Winona, Minn.
Durham, N. C.
Williamsport, Pa.
West Chester, Pa.
Beaufort, S. C.
Houston, Tex.
La Crosse, Wis.
Port Townsend, W. T.
Light-house on Destruction Island, W. T.

BRIDGES.

Bills have been introduced for the following:

Construction of bridge over Missouri river at or near Sibley, Mo.
Across Missouri river at or near Decatur, Burt county, Neb.
Across Missouri river between its mouth and the mouth of the Dakota or James river.
Across Mississippi river between St. Paul and Natchez, Miss.
Across Illinois river between its mouth and Peoria, Ill.
Across Missouri river within five miles of Rulo, Richardson county, Neb.
Across Missouri river between north and south lines of Douglas county, Neb.
Petition for bridge across St. John river, Aroostook county, Me.
Across Hudson river between Storm King and Break Neck Mountain, N. Y.
Across Potomac river at Georgetown, D. C.
Across Williamette river, Oregon.
Across Mississippi river at Memphis, Tenn.
Over Rio Grande river between Laredo, Tex., and Nuevo Laredo, Mexico.

PUBLIC WORKS, ETC.

Bills have been introduced for following:

Improvement Suwanee river, Fla.
Continuance work on channel between Cumberland and Amelia Islands, Fla., and the entrance to Fernandina, Fla., and St. Mary's, Ga.
Improvement of channel at Key West.
Continuance work on St. John's river, Fla.; also for improvement of same.
Improvements certain channels, rivers and harbors of Florida.
Establishment of navy yard, Algiers, Mississippi river.
Improvement of Pensacola Harbor.
Survey for canal between Upper Missouri river and Columbia river.
Immediate appropriation of $1,000,000 for preservation, &c., of certain works for improvement of Mississippi river.
Providing for construction of Michigan and Mississippi river canal.
Continuance of the work at Sand Beach, Lake Huron, Mich.
Breakwater at Little Traver's bay, Mich.
Opening of passage through San Carlos bay, and improvement of Caloosahatchee river, Fla.
Ship canal between Lake Union and Washington and Puget Sound, W. T.
Several petitions have been received, asking that the Secretary of War be authorized to contract with Charles Stoughton for the entire work of improving Harlem river.

MISCELLANEOUS.

Construction of road to Chattanooga Cemetery.
Monument at Frederick City, Md., over grave of Francis Scott Key, the author of "The Star-Spangled Banner."

Glass at Charleston, W. Virginia.

The following is a synopsis of bids for glass for the post-office, court-house, etc., at Charleston, W. Virginia, opened January 3, 1884:

Wm. Glenny & Co., American, $600; foreign, ex. of duty, $490.
Crystal Plate Glass Company, American, $600.
E. A. Boyd & Sons, American, $623.54; foreign, ex. of duty $493.19.
De Pauw's Plate Glass Company, American, $659.
Healy & Millet, American, $676.
French Silvering and Ornamental Glass Company, American, $656.16.
London and Manchester Glass Company, American, $710; foreign, ex. of duty, $596.
John Gibson, American, $825.
George H. Gibson & Company, American, $757.50.

The bid of Wm. Glenny & Co., excluding import duty, $490, the lowest, has been accepted.

IRON FURRING AND LATHING AT MEMPHIS, TENN.

The following is a synopsis of bids for iron furring and lathing for the custom-house, etc., at Memphis, Tenn., opened December 14, 1883:

Haugh, Ketcham & Co., Indianapolis, $2,821.15. Additional work—furring and lathing for ceilings, per square foot, 12c.; furring and lathing cornices, brackets, etc., per square foot, 17c.; plain lathing, such as covering ventilating flues, etc., per square foot, 10c.

John W. Hoyt, $3,664. Additional work—furring and lathing for ceilings, per square foot, 22c.; furring and lathing cornices, brackets, etc., per square foot, 30c.; plain lathing, such as covering ventilating flues, etc., per squre foot, 16c.

Knisely & Miller, Chicago, Ill., $3,398. Additional work—furring and lathing for ceilings, per square foot, 18c.; furring and lathing cornices, brackets, etc., per square foot, 25c.; plain lathing, such as covering ventilating flues, etc., per square foot, 10c.

The bid of Haugh, Ketcham & Co., the lowest, has been accepted.

MARBLE MANTELS AT TOPEKA, KANSAS.

The following is a synopsis of bids for marble mantels, with hearths, for the court-house and post-office at Topeka, Kans., opened January 3, 1884:

Pickel Stone and Marble Company, $1,453.50.
Davidson & Sons, $1,495.
Burlington Manufacturing Company, $1,574.25.
Chas. E. Hall & Co., $1,635.
Emile Fritsch, $1,970.
A. Klaber, $2,628.
Robt. C. Fisher, $3.399.

The bid of the Pickel Stone and Marble Company ($1,453.50), the lowest, has been accepted.

HYDRAULIC ELEVATOR FOR TREASURY BUILDING, WASHINGTON, D. C.

Synopsis of bids for hydraulic elevator for cash room, received under advertisement dated December 12, 1883, opened January 3, 1884:

Whittier Machine Company, $2,755; seven weeks.
Otis Bros. & Co., $2,980; four weeks.
Reedy's Elevator Works, $3,220.
George C. Howard, $2,500; two months.
Decision will be made in a few days.

NEWS OF THE WEEK.

Water, Gas and Steam.

WORK will begin on Newton, Kan., waterworks in a few days. The elevated reservoir will be set on a masonry tower 70 ft. high; tank will be 60 ft. high by 35 ft. diameter. T. S. Moorhead is the engineer.

THE Jersey City Board of Works is considering a plan for supplying New York with water by means of pipes laid from its works at Belleville to the river and across this by means of submarine pipes. The board has asked the Mayor to appoint committees from the various boards interested to consider the matter.

THE Niagara Falls water-works company, with a capital stock of $40,000, has expended $39,684.86 for mains, hydrants and service pipe. The expenses in 1883 were $3,855.19, of which $2,131.15 was paid to the Water Commissioners of the suspension bridge for the water furnished by them. The revenue for water rates was $6,628.83, enabling the company to pay $3,200 in dividends and to declare a 4 per cent. dividend for Jan. 1884.

CLAY CENTRE, KAN., Jan. 12.—The city council adopted an ordinance last night providing for the Holly water-works system similar to that now used in the cities of Topeka, Salina and Abiline. The work is to be completed by July 1.

Many important improvements, both public and private, are contemplated for the present year, among which are a $50,000 court house, a $20,000 Masonic temple, a $10,000 Odd Fellows hall, new opera house and several business blocks and private residences.

WORK has been commenced on the east end of the water tunnel at Lynn, Mass. About 140 ft. east and west of the central shaft has been completed. The total length of tunnel is 1,328 ft. It was to be completed by March 1st. There is at present some difficulty between the contractors and the Water Boards concerning payment for the central shaft, which, it seems, has proved unnecessary.

THE Deane steamp-pump company, of Holyoke, Mass., have fitted up the necessary pumping aparatus for the water-works of nine cities within the past few months, costing from $4,000 to $16,000 each. They are at work on five more of these pumps and engines, and three large pumps, one of which is 28-inch diameter, are ready for export. The company are running their works on full time and they employ about 225 men in the different departments. The past year has been a prosperous one with the company, the business having been in excess of any former season.

Contracting Miscellany.

R. W. JORDAN, a Minneapolis contractor, has begun suit against R. L. Berglund, a sub-contractor, alleging a debt in one of $31,143, and in the other of $3,632.

MR. HILL has introduced a bill into Congress to require a government building to be erected in every town and city in the Union in which the postmaster draws a salary of $1,000 and over. Mr. Hill says his policy would save the government one million dollars per year rent.

ST. LOUIS, Jan. 2.—Judge Lubke of the Circuit Court to-day decided the long-standing case of James Andrews against the St. Louis Tunnel Railroad Company, Barton, Bates and Charles E. Tracy, for money claimed by Andrews to be due him as a contractor for building the tunnel from the bridge to the Union depot, ten years ago. The Court awarded a special judgment for the plaintiff for $119,228.

LYNCHBURG, VA., Jan. 11.—A shooting affray occurred yesterday at Dublin, Pulaski county, resulting in the serious wounding of Robert Dodd, a railroad contractor, by a bar keeper named Toddii. Dodd was shot through the right lung and in the right arm.

CONTRACTS for the iron work on the Saugus tunnel were awarded by the city of Lynn, Mass., to the Chelmsford Iron Works at $2661.52 and to J. L. Whittredge, of Lynn, for the stone work at $1072.89.

THE taxpayers of Lake View, Ills., near Chicago, allege two grievances: First, that the assessment for sewers was too high; and, second, a brick instead of a tile sewer should be laid in the street. Mr. Hanslein, a sewer builder, said a pipe sewer ought not to cost at most over $2 a foot, and a brick sewer not over $3, and the assessment called for $3.80 per foot for a pipe sewer. Mr. Haley, another sewer builder corroborated Mr. Hanslein's statement.

NEW ORLEANS, LA., Jan. 11.—The levees on the Mississippi river at Hardscrabble, Bondurant and Kempe, which are being built under the auspices of the Mississippi Commission by P. J. Kennedy, contractor, are in such a state of backwardness and delay that hope of their being finished by the contractor in any reasonable time has been abandoned. Under these circumstances the contracts have been declared vacated by the officers of the Government representing the River Commission, and the Government will at once take charge of the work, hire a sufficient number of laborers, and rush these works to completion before the spring floods can overtake them. It is believed that the work can successfully be done in spite of the lateness of the season. If not done, a great deal of the labor performed and money spent the past season will go for naught.

CONTRACTS for grading Blue avenue between this city and Independence, were let by County Surveyor Flaherty. The contract for grading section 4, containing an area of 15,000 square yards, was awarded to James Lillis at 24½ cents per cubic yard of rock. Peter Soden secured the contract for section 5, at 24½ cents for dirt and 70 cents for rock. This contract is for 70,000 yards. The remainder of the seven miles is to be graded by Mr. S. F. Scott, who was awarded the contract for section No. 6, at 24 cents for dirt and 80 cents for rock. The contracts for the other sections, 1, 2, and 3, reverted to Mr. Scott by virtue of his being the bondsman of Burk, Finskey & Co., to whom the contract was awarded last August, upon their refusal to carry out the contract. This contract is for nearly four miles of grading and will foot up $40,000. The grading is to commence as soon as the weather will permit and must be completed within five months. The whole work will cost in the neighborhood of $100,000. —Kansas City *Times*.

THE valuation of the total production of the Leadville district, since the discovery of gold, in 1860, amounts to $81,698,905. The production for the last five years has been as follows: 1879, $10,333,740; 1880, $15,025,135; 1881, $13,147,257; 1882, $17,127,402; 1883, $15,538,446. Total for five years past, $71,171,980.

THE Boston Water Board opened proposals for furnishing 50,000 cubic yards of filling for the Farm Pond conduit. The board took the matter under consideration in view of three bids, only one of which was considered formal, that of Parker & Sylvester, at 47 cents per cubic yard. The other bids were Monson & Co., at 30 cents per cubic yard, and A. F. Williams & Co., at 75 cents.

Railroads.

IT is reported that the Trustees of the Brooklyn Bridge propose to bring action against the Manhattan Railway Co., compelling them to remove the station from in front of the New York approach to the Bridge. All attempts at an amicable adjustment have failed.

SENATE bills to incorporate the James River and North Carolina Railroad Company; to incorporate the Richmond Union Depot Company; and to provide for removing obstructions in Bush River, in Prince Edward county, Va., have passed the Virginia Legislature.

ARTICLES of incorporation of the New York, Rock Island and Omaha Railroad Co., which contemplate the construction of a railroad from Chicago to Rock Island, and thence to Des Moines, Iowa, were filed in Chicago on January 12.

THE railway tunnel under the Mersey (England) is on the point of completion, and communication between the shores was expected to be opened on Wednesday of this week. This tunnel is a little less than one mile long; it is lined with brick.

THE Reading Railroad Co., after laying ties and rails on the snow and ice, in their efforts to block the entrance of the Pennsylvania Railroad to Pottsville from the South, has been served with an injunction, returnable on January 22.

CHICAGO, Jan. 12.—The *Daily News'*, Springfield, Ill., special says articles of incorporation of the New York, Rock Island and Omaha Railroad Company, which contemplates constructing a railroad from Chicago to Rock Island, and thence to Des Moines, Ia., were filed to-day.

AMONG the changes effected in the management of affairs on the Panama Railroad since the sale of the bulk of the shares to the representatives of the canal company is one involving the entire repair of the line, the construction of new tracks and sidings in the yards, and the erection of five stations at different points along the road.

THE United States steam surveying vessel Ranger left Aspinwall on the 4th inst. for the Central American coast, to continue the scientific work intrusted to her to perform. Her surveys show that many of the headlands and points are six and seven miles out in the charts at present in use. New ones will be printed during the present year in Washington.

CHICAGO, Jan. 7.—The *Journal's* Springfield, Ill., special says the incorporation of the Lake Erie and Mississippi Railway Company was effected here to-day, with Columbus R. Cummings, Geo. A. Ives, John B. Cohoes and Luther M. Dearborn as incorporators, and who constitute the first Board of Directors. The Company is formed to construct a road from Bloomington to Peoria, Ill., and thence west to the Mississippi River.

THE North River Construction Co. has gone into a Receiver's hands, ex-Judge Ashbel Green. This action is taken to protect about $20,000,000 of West Shore stock, now in the hands of the Construction Co. The North River Construction Co. was started three years ago with $10,000,000 capital; it built the West Shore Railroad from Cornwall to Buffalo and Albany, and is reported to have spent $55,000,000 in this work. The present indebtedness is several million dollars.

OTTAWA, Ontario, Jan. 15.—Advices from British Columbia state that work on the Canadian Pacific Railway in that province is being very imperfectly carried out. The work done on the Onderdonk contract is reported not to be in accordance with that called for in the Government specifications. The railway wharf built at Port Moody, a little over a year ago, is already decaying. It is believed that huge jobbery will yet be unearthed in connection with the Port Moody-Savona ferry contract, embracing a distance of 213 miles, and involving an expenditure of $10,000,000, irrespective of millions for extras.

JAMES A. EVANS, Chief Engineer of the South Park Division of the Union Pacific, in answer to inquiry states that the work is progressing satisfactorily on the extension to Leadville. The ties are bedded and only seventeen miles of rail remain to be laid. Mr. Evans says that if the weather is favorable he will complete the work by February 6, at which time the Union Pacific's contract with the Denver and Rio Grande expires.

A CHARTER was filed with the Secretary of state, of Kansas, incorporating the Topeka Circle Railroad Company. It is proposed to build a narrow guage road along the south bank of the Kaw river to Martin's hill, a point five miles west of the city, thence run in a southeast direction back to Washburn college, and around the southern limits of the city to the place of starting. Judge John Martin is at the head of the enterprise. The capital stock is placed at $100,000.

WICHITA, Kan., Jan. 9.—The board of trade of this city met to-day, and passed resolutions strongly indorsing the enterprise known as the Wichita, McPherson and Denver Railroad. The company has been organized by the election of J. W. Hartzell, president and general manager; Randolph Hatfield, treasurer; Oliver Mulroy, chief engineer, and O. H. Bentley, secretary and attorney. This company means business, and they are receiving substantial encouragement from people along the projected line and are strongly backed by eastern capital.

BUFFALO, N. Y., Jan. 11.—Representatives of the Delaware, Lackawanna and Western Railroad are here negotiating for the purchase or lease of the line of the Buffalo, New York and Philadelphia Road, between Buffalo and Brocton, a distance of 50 miles of completed road, with the purpose of immediately extending it to the Wabash system and eventually to Chicago. This would form a parallel road to the Lake Shore and the New-York, Chicago and St. Louis Roads. The surveys of the proposed extension were made last fall. A proposition has been submitted which it is believed will be accepted.

WASHINGTON, Penn., Jan. 15.—L. B. McCabe, one of the contractors on the extension of the Hempfield Railroad to Connellsville, is in town. A few men have already gone to work, and within six weeks it is expected that 300 will be engaged at the tunnel east of the town. Two car-loads of horses from Baltimore, and a number of horses, carts, and cars are expected from Connellsville in a few days. The right of way has nearly all been secured over the entire route. Work has begun on the tunnel referred to several times—first in 1852, again in 1872 and 1873, also about two years ago—but each time a halt was called. There is now every assurance that the road will be pushed rapidly to completion.

THE College Hill Tunnel in Providence, R. I., was let, on January 12, to Reon Barnes, of New York. Work is to begin in ninety days, and the tunnel is to be finished in eighteen months from date of contract. This tunnel is intended for a street. It will be 32 ft. wide, 17 ft. high in the clear, and is 1,400 ft. long, or, including approaches, 2,050 ft. long. There will be a side walk 8 ft. wide on the north side, and a driveway permitting three carriages to pass abreast. At Prospect Street, about the apex of the hill, an elevator will be provided for the use of those who do not care to go to either entrance of the tunnel. It will be furnished with a noiseless pavement and lighted by electricity or gas. The total cost is to be $600,000. It is built entirely by outside capital.

PARLIAMENTARY committes, in England, are likely to be engaged for some time in the consideration of the relative merits of the many schemes offered for crossing the River Thames, below London Bridge. The Metropolitan Board proposed a tunnel to cross the Thames from Nightingale Lane to Dockhead, a steam ferry at Woolwich, and one at Greenwich. The corporation of the city proposed to establish free ferries, and to apply the income of the Bridge House estates to that purpose; the undertaking of the Thames Steam Ferry Company (Limited), and the widening and improvement of Tower Hill, are included. A company will seek for authority to make opening bridges at the Tower, at Stepney, and at Greenwich. A subway in the bed or foreshore of the Thames is proposed in connection with each bridge. Another company will propose the construction of a navigable channel from Blackwall across the Isle of Dogs to Limehouse, the establishment of three steam ferries across the Thames, and a free steam ferry across the new channel. It is also proposed to construct a subway under the Thames, commencing in the vicinity of Newington Butts and terminating in King William street, in the city.

IRON, METAL AND COAL MARKETS.

PHILADELPHIA, Jan. 17, 1884.

All the evidences, cropping out as to the future course of the Iron trade, are in favor of a steady demand, but no improvement in prices. This is the opinion of the best authorities in the trade, brokers who are most anxious for better prices, admitting that the probabilities are against them. A comparatively large amount of Forge Iron has been sold during the past week, while Foundry is neglected on account of the probability of lower prices. A good many brands are now selling at $20, which were sold before at $20.50, while very little sells above $21, though some special brands always command that or higher prices. A few large buyers are in the market, but decline to buy excepting on concessions which it is impossible to grant. A few more furnaces have blown in, and in February half a dozen more will follow. This will increase the output and serve to warn buyers not to buy too heavily. The mills are resuming slowly but full production will not be made this month; hence the demand for Crude Iron will be only moderate, at from $17.50@$18.50. Negotiations for Bessemer are still pending but buyers decline to accept the situation, and will pay only $19.50. Spiegeleisen is wanted at $28@$28.50, but very little can be had even at $29. Scotch Iron is irregular and only selling in small lots as wanted from week to week. Arrivals of Ore and Pig Iron are increasing but the total foots up very little. The resumption in iron making since the holidays, has not been attended with any change in the situation, nor improvement in price, and there is no prospect of any. Quotations for Bar Iron are 1.75 for common and 2c. for best, but the latter figure is only for small lots. The Nail trade is improving in consequence of the eastern strike and western suspension. Price, nominally $2.40. Jobbers are ready to buy at 2.30 for car load lots. The Steel Rails are in better shape than they have been for months.

PITTSBURGH, Jan. 17, 1884.

To-day's quotations in Pig Iron are, Neutral Gray Forge, $16.50@$17; Red Short, $17.50@$18; Bituminous Foundry, $20; Coke Iron, $20@$20.50; Charcoal, $26@$28; Bessemer, $21. Stocks at local furnaces are declining. Nails, card price, $3.40; selling price $2.40 for car-load lots. Merchant Iron is dull at $1.70@$1.80, a few small lots sell a little higher. There is no room for a further decline, but some manufacturers are selling at a sacrifice, in order to get rid of stocks and making profits only on special lots. Buyers are looking out for opportunities of this kind. Western Pennsylvania nail makers are pleased at the suspension in the East, and predict firmer prices as the result. Old Rails are quiet at $24. Several thousand tons are wanted but that price will not be paid. Crop ends, $23.50@$24.50 for foreign. Nominal quotations for Steel Rails, $36@$36.50, but the outside figure offered by buyers is $34.50.

CHICAGO, Jan. 16, 1884.

During the past week business in all of our leading iron houses has been quiet. Many of the iron mills are starting up, and some of them, though not all, have a good supply of orders, and are contented with the prospects of the immediate future. Bar Iron remains unchanged, being quoted in an ordinary jobbing way at 2c. There is a little more firmness in price, which buyers think may soon result in a slight advance. Structural Iron is quoted as follows: Tank, $2.60; Angles, $2.70; Beams, $3.60; Channels, $3.80; Shell, $3.50; Flange, $4.50. Norway and Swedish Bars are dull. Russia Iron is quiet at unchanged prices. The Nail trade is dull and quiet. $2.70 is quoted for small lots and $2.60 for large lots. Scrap Iron is dull at $17 per net ton for No. 1 wrought. There is fair trade reported in the finer grades of Steel, with a fair amount of inquiry. Pig Iron is in good demand. Lake Superior Irons are in fair demand, and Southern Cokes in fair request. The hardware trade is improving and jobbers anticipate good business throughout the season. Business, in a general way, is rather disappointing, but the whole trade is hopeful of a good demand later in the season.

COAL.

PHILADELPHIA, Jan. 17, 1884.

The latest report from the coal fields is, that the suspension is rigidly adhered to, in all quarters, and restriction will be continued through the spring if necessary. The willingness of the companies to continue this policy has its meaning to the trade. The miners object to this long idleness, but there is no escape. Selling prices are unchanged, and large purchases can be made at the usual shading below circular rates. There are rumors of an improvement in manufacturing demand, but as yet it has not been felt. A few mills and furnaces have resumed and some are working full, but this increased demand will be too light to affect the heavy output. Western consumers are making inquiries for larger supplies and a like spirit of inquiry is shown in the South, while the stocks of New England consumers are very low, and their requirements will be in market early in February. Bituminous coal operators have not yet agreed upon a plan for the control of production and prices. They will enter the spring trade in as bad a shape as last year, and probably with no favors from railroads.